

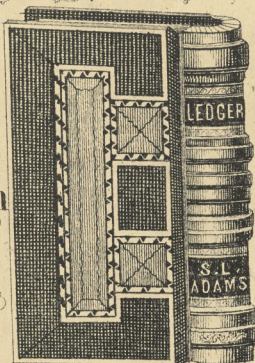
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Chemistry

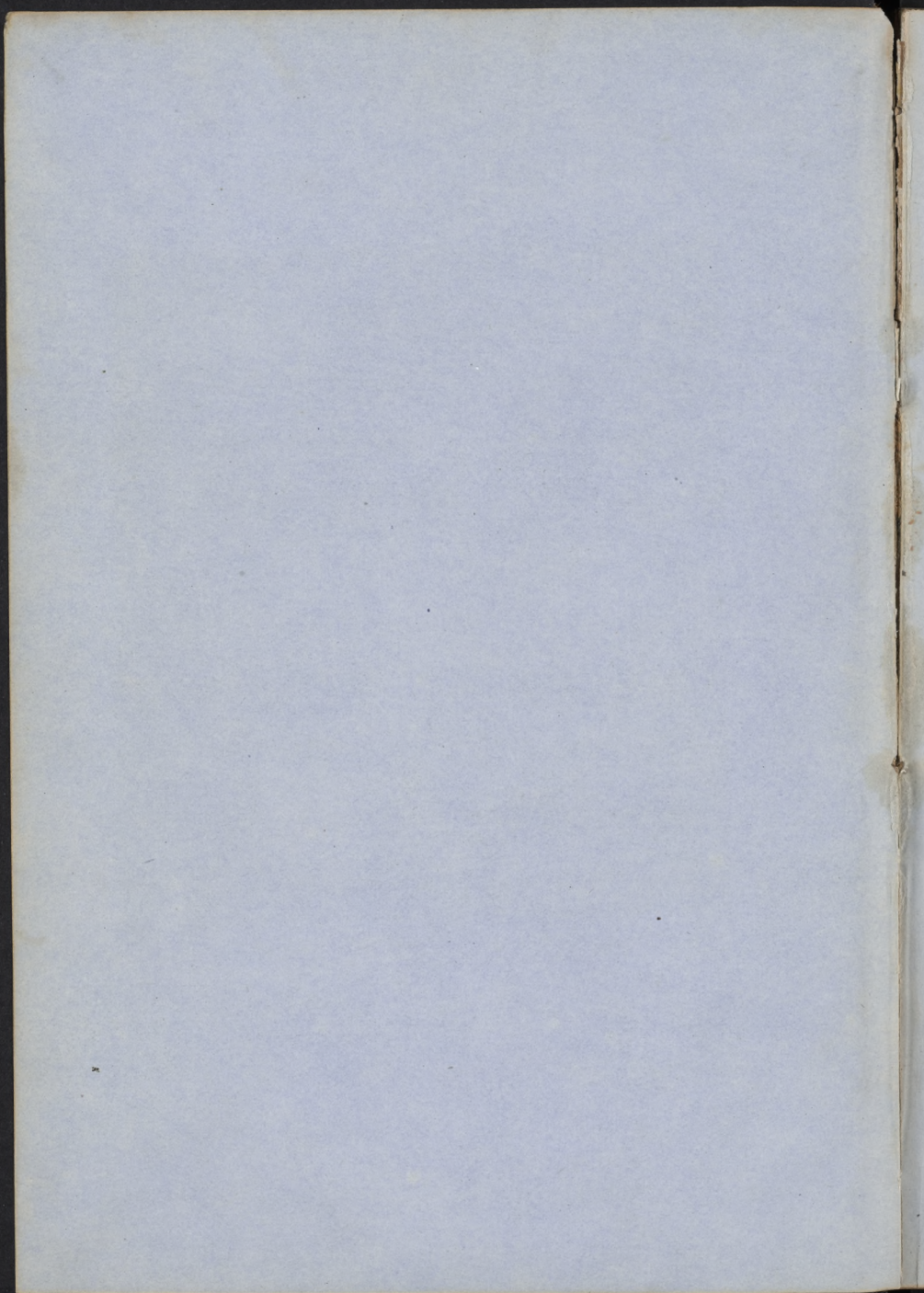
Notes by Josiah Cohen

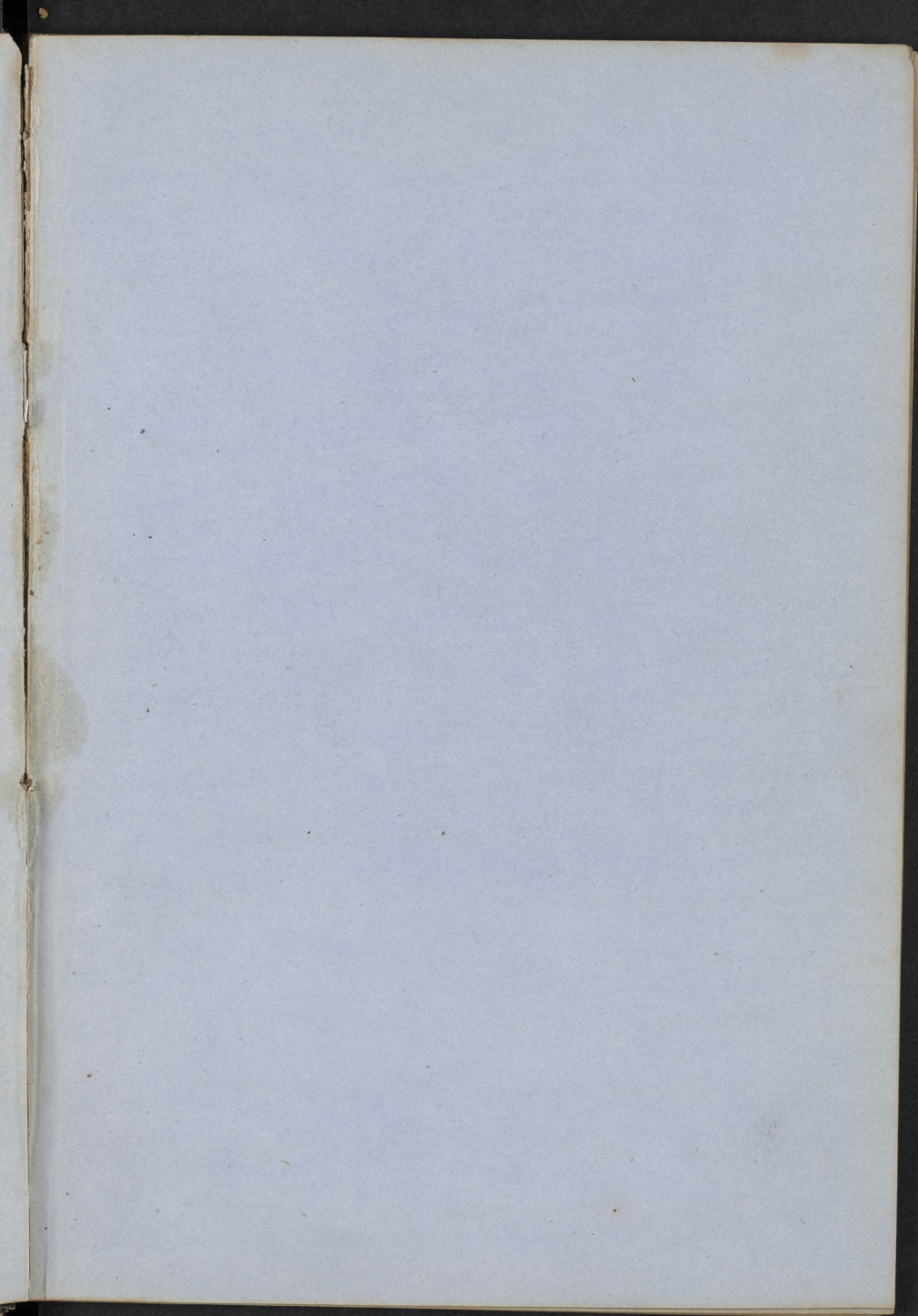
Prof Bauche

Jeff. Medical College

1856-7

I





Chas. May 1850

Dear Sir

I have the honor to acknowledge the receipt of your letter of the 10th inst.

in relation to the matter of the 10th inst.

and in reply to inform you that the same has been forwarded to the proper authorities.

I am, Sir, very respectfully, your obedient servant.

Yours truly,

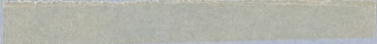
Wm. L. G. May

Secretary of the Board of Commissioners

of the City of New York

City Hall, New York

Enclosed for you are the papers in relation to the matter of the 10th inst.



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Introductory Lecture delivered

October 14th 1856

In accordance with the time honored Custom pursued in similar institutions, I appear before you to open my 16th Course of lectures in this College. Many lectures have I in that time delivered, several of which have been printed in which I have presented a number of facts Connected with the branch it is my business to teach. When I began the study of medicine 46 years ago, the usage of medical professors, was to deliver the same introductory every year, as if the view taken was that such addresses like rare wines became the better, the older they grew. This view of the duty of the teacher is no longer acted upon, and the professor of the present day feels obliged to deliver a new discourse Every year, or at least one that is new to the class he addresses

in a crucible with a perforated Cover & exposed for two hours to a white heat. When Cold it is again reduced to a fine powder & the preparation is finished. In London & Dublin the Sb_2S_3 is roasted with twice its weight of horn & then treated as above. The powder is like flour & is insoluble in water. The Safest antimonial is Tatar Emetic which should always be purchased in crystals. There are three Combinations of Sb and Cl; $SbCl_3$, $SbCl_4$, and $SbCl_5$. $SbCl_3$ in aqueous solution is Antimonii Trichloridi Liquor Dub, made by dissolving Sb_2S_3 in muriatic acid forming H_2S & $SbCl_3$. $SbCl_3$ is a soft yellowish white solid formerly called Butter of Antimony. It is fusible & deliquescent but may be made crystallized. It is soluble in water only to a certain extent without decomposition. Trichloride of Antimony is made by adding the solution of $SbCl_3$ to water. It is called the powder of Algaroth & is composed of Sb_2O_3 & $SbCl_3$ with H_2O . When treated with Soda it becomes all teroxide,

Introductory

In casting about for a subject on which to address you this evening, I have thought that some general observations on the choice of a profession or Calling, and on the proper mode of directing your Studies, in case that choice should be the medical profession, might be appropriate to the present occasion.

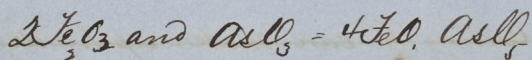
And while pursuing this topic, I shall introduce a number of opinions tending to shew, how indispensably necessary a knowledge of chemistry is to the medical man, in early youth, and endeavour to explain to you the simple characteristics which fit a person for the medical profession. When we observe a boy who sympathizes with the sick and infirm, and tries to give them all the assistance in his power, and as he approaches manhood, is ready and willing to wait upon the infirm, and feels anxious to sit up with the sick, and feels pleased if he can make himself

and the trisulphuret is driven off. Subsulphate of
 Ferroside of Antimony is $2SbO_3 \cdot SO_3$ and is employed
 in the London Pharmacopoeia to make Tartar
 Emetic. It is made by acting on SbS_3 with SO_3 at a
 gentle heat. S is given off as Sulphurous acid
 and we get a substance $SbO_3 \cdot SO_3$ which is washed, &
 SO_3 is partly given off leaving $2SbO_3 \cdot SO_3$. Antimonious
 acid is denied by many to exist & is thought to be an
 Antimoniate of the teroside of antimony, a combi-
 nation of the teroside and quintoxyde of antimony,
 or antimonious acid

LXII. Arsenic. *As.* 75. *Sp.gr.* 5.8. *Arsenicum* Us. Brands 733

As with $O - (AsO_3)(AsO_5) - As with $S (As_2S_3)(As_3S_5)As_5S_8$
Acidum Arseniosum. Us. $AsCl_3$ - *Sp.gr.* 3.7 Soluble in
 66 parts Cold water & 12 parts boiling water$

Ferri Oxidum Hydratum Us. Antidote for AsO_3
 discovered by Benson & Bertholde in 1834



Arsenic Acid $AsCl_5$

Introductory

useful, and has not in his composition the sickly sensibility of those who allege themselves incapable of giving assistance or relief to the Sick, because they are too tender hearted to bear the Spectacle of Suffering: the boy who possesses such a disposition should be made a physician, for his moral qualities point out his fitness for the medical profession.

If a young man possessing these qualities is determined to embrace this profession, one question remains to be answered. "Does he possess an adequate preliminary education?" This is a very important question. The least preparatory education comprises a knowledge of the rudiments of the English language the elements of mathematics &c. If he does not come up to this standard, he is not debarred from entering the profession. If he chooses and is earnest in his Calling, he can make up his deficiency by improving himself in the requisite studies

Bisulphuret (realgar) As_2S_3 Tersulphuret (apiment) As_2S_5
 Trichloride $AsCl_3$ - Liquor Arsenii Chloridi Sord }
 Lebalangius Solution

Arsenici Iodidum US. AsI_3

Liquor Arsenici et Hydrargyri Iodidi US. (Donovan's Solution)

Arsenite of potassa KO, AsO_3 - Liquor Potassæ Arsenitis US
 Fowler's Solution

Arsenic is found in earth Combined with various Substances as arsenites; with Oxygen & Sulphur, in the form of Arsenical pyrites. It is often found Combined with Cobalt, and is obtained by exhibiting the Cobalt ores to heat. Arsenic is a volatile metal and may be obtained by Subjecting the Commercial metallic arsenic to a subliming heat in a glass tube. The metal is brittle and Can be Subjected to powder in a mortar. It may give a Smell like garlic. All its Combinations are eminently poisonous. It forms two Compounds with Oxygen both of which are acid, Arsenious and Arsenic acid. There are three Combinations

Introductory

that are desirable. It is not absolutely essential for a medical student to be a complete Latin Scholar. He may gain by self-instruction a sufficient knowledge of the Latin language by taking one hour every day for studying it, and if he have a preceptor to help him occasionally he may acquire more than is requisite in life time. The next most important language to be studied is the French, of which enough should be acquired to enable you at least to read fluently. If you wish to add to your accomplishments in languages, the German should be the next you should learn on account of the rich store of medical literature it contains. I neglected this important branch in early life, and found myself obliged to commence the study at the age of 40 and made sufficient progress to assist me materially in my medical and chemical studies. If it is the intention of a youth, or his friends, to devote

with Sulphur, a bisulphuret, a tersulphuret, and a quintsulphuret. Arsenious acid is officinal in the US pharmacopœias. It is obtained in the chimney of cobalt furnaces farther from the fire where the vapor has had time to be teroxidized as it passes along. When this is Sublimed in iron vessels it is obtained pure in large lumps. At first it is translucent, but afterwards it becomes opaque like porcelain. It is a virulent poison and its chief effects fall on the stomach. Even when it is injected in a recent wound. It is popularly Called Arsenic, also white arsenic, and oxide of arsenic. The tests for arsenious acid are important. Three good ones are Ammonio nitrate of protoxide of Silver; Ammonio sulphate of protoxide of Copper, and Sulphuretted Hydrogen.

Ammonio Sulphate of protoxide of Copper throws down a green precipitate. Ammonio nitrate of protoxide of Silver throws down a yellow precipitate. Sulphuretted hydrogen passed through a solution of

Introductory

himself to the medical profession, it is a very useful beginning to place himself for several years with some druggist or apothecary, say from the age of 15 to 18. This will enable him to become familiar with the medicines usually prescribed, and he will thus get an insight into a number of things, which will prove highly advantageous in his subsequent career, and this forms that kind of practical knowledge in relation to which medical men are often deficient. The best time to commence the regular study of medicine is at the age of 18, about the spring of the year, at the period when the lectures of the principal medical schools terminate and the commencements are held. By making a beginning at this time, the necessary 3 years of study will end in the spring. If you be under the necessity of restricting your attendance on the lectures to two seasons, you should precede

Arsenious acid will, after a while throw down a yellow precipitate. Another test is by putting an arsenic ~~test~~ Compound among the ingredients for generating hydrogen, when arseniuretted hydrogen will be formed. When set fire to, the flame impinging on a Cold Surface will produce a black stain. The materials used for obtaining pure hydrogen must contain no arsenic. Another expedient consists in acidulating the matter with a little muriatic acid and putting into the solution some Copper foil. The arsenic will make a white surface on the Copper. Cut this up, put it in a test tube and expose it to a red heat, when arsenious acid will crystallize in the tube with an adamantine lustre. The antidote is hydrated Sesquioxide of iron of U.S. Pharmacopoeia, which should be kept under water in a moist & pulpy state. The antidote makes an insoluble Compound with arsenious acid, the arseniate of protoxide of iron. Arsenic acid is made by acting on arsenious acid with an excess of Nitric Acid. It is a white deliquescent

you studies, by reading for 18 months under the
direction of a private preceptor. A student may
thus make progress if he pursue a judicious course
and may thus study human anatomy as far as the
books can teach him, and gain an early knowledge
of the soft parts theoretically, but the practical
knowledge of this & other branches is deferred until
the student is enabled to repair to a medical school.
The student may even in the country make
himself dexterous in the use of the Scalpel or
dissecting knife by dissecting inferior animals
wild and domestic that are in his neighborhood.
No one is justifiable in using the knife upon a
living body, who is not familiar with the dissec-
tion of the dead. The student can in the same
interval of 18 months make himself acquaint-
ed with all the drugs and medicines of which he
can obtain samples. There he should study

substance very poisonous. It is precipitated brick red by a solution of nitrate of protoside of Silver. Arsenic unites with Chlorine. The trichloride is officinal in the London Pharmacopoeia. It is made by dissolving 30 grains $AsCl_3$ in one & a half fluid drachms of muriatic acid, 20 fluid ounces of distilled water is added when it is *Liquor arsenici chloridi* Lond & is called *Hebalanguis* Solution. There is an officinal iodide of arsenic which is used to make Donovan's Solution. Arsenic \mathfrak{zj} and Iodine $\mathfrak{z\text{v}}$ are heated gently *Liquor Arsenici et Hydrargyris Iodidi*. Dissolve \mathfrak{ss} of each 35 grains of triiodide of arsenic & Iodide of mercury in $\frac{1}{2}$ pint of distilled water. Then add two sets of salts, Arsenites and Arseniates. An important Compound is Arsenite of potassa an aqueous solution of which forms Fowler's Solution made by dissolving 64 grs AsH_3 by the aid of an equal weight of pure Carbonate of potassa, and 12 fluid ounces of distilled water, add $\frac{1}{2}$ fluid ounce of Spirits of lavender to give it taste & enough distilled water, to make the mixtureaping.

attentively until he becomes acquainted and satisfied, as to their forms, color, taste, smell, properties etc. and always with the sample before him. In this way he will become familiar with different substances, and be able, in after life to recognize them whenever he meets with them. Next, he will do well to make himself acquainted with the natural history, and powers of different medicines to which he may have access, whether of the mineral, vegetable or animal kingdom. It is true, some important medicines may not be within his reach, and he should postpone attention to them until he can obtain specimens. The principles of their chemical relations, requires an amount of knowledge not attainable by private instruction, and their study should be postponed until the student has an opportunity of attending chemical lectures.

Chromium. Cr. 26. Sp. gr. 6. Vanquelin 1797

Cr with O - Sesquioxide Cr_2O_3 - Chromic acid CrO_3
3 Chromates

Chromate of potassa KO, CrO_3

Bichromate of potassa $\text{KO}, 2\text{CrO}_3$ official Dub.

Chromate of protoxide of lead. PbO, CrO_3

$\text{KO}, 2\text{CrO}_3$ and $4\text{SO}_3 = (\text{Cr}_2\text{O}_3, 3\text{SO}_3 + \text{KO}, \text{SO}_3)$ and 3O^\uparrow

Chromium is a brittle metal. Chromic acid is deliquescent. Sesquioxide is a basic oxide.

Chromate of potassa is made by acting on chrome iron in powder by saltpetre. It is a yellow salt.

Dissolved in water and acidulated with Sulphuric acid, there are formed crystals of Bichromate of potassa of a beautiful red color. Monochromatic gives characteristic precipitates, red to nitrate of protoxide of mercury, darker with AgO, NO_2 and with PbO, NO_2 - beautiful yellow color.

You should make it a point to become familiar
 with the indigenous plants that grow in your
 neighborhood, and collect them at the proper season
 this will form a good exercise for you, and prove
 a highly instructive occupation; the specimens should
 be well dried between folds of coarse blotting paper;
 and these should be carefully put away with their
 botanical and common names attached. He should
 also study such varieties of foreign plants as
 are cultivated in our gardens. In this way you
 will readily form a useful collection of medicines
 for your Herbarium, and may perhaps excite a
 taste for botany which might otherwise lie dormant.
 The medicines to which you have access may be
 studied in any relation; you may investigate their
 physiological action, their action upon the body
 in health; in this case your experiments must
 be made upon yourselves, and will do you no

Organic Chemistry

LXIII

1. W Table -

1. When O more than sufficient to form H_2O with H ... an acid
2. When H , C , & H , exist together with or without O - (generally) - a base
3. When H and O in proportion to form H_2O (generally) - neutral
4. When C and O are both in excess - an alcoholic, ethereal, oily, or resinous Compound
5. Certain groups of proximate Constituents have a Common radical
6. Many organic Substances may be represented by two other Substances added together.
7. Certain groups of organic Substances Compounds are derived from a model Compound, by the replacement of one element by another.

Organic Chemistry is the chemistry of organized substances derived from the vegetable and animal Kingdoms. Examining organic Substances which consist of certain elements, we obtain those elements by analysis and they are called ultimate constituents

harm. The trials you make, will tend to render you familiar with the effects of different doses of medicines, and will not be dangerous, as it is not likely that you will overdose yourselves. Before leaving this subject I must caution you against the practice of confining your experiments to one branch of the Materia Medica, or to one article, instead of investigating a number. I have found students, who have for weeks, and months, nay even years, confined their experiments to determining the physiological action of Tabacum, and you will find them persisting in their investigations for many years after they have left College, while the same perseverance directed to a number of medicines, would have enriched our Science with many important facts concerning their qualities. As a substance having general properties for stimulation, fumigation and mastication, no article in the Materia Medica has received an equal share of attention.

of organic substances. Many organic substances are so complex that they are formed of compound substances and when we obtain these we have the proximate constituents of the organic substance. These two, form proximate and ultimate analysis. The elements in vegetable matter are C, H, and O. In animal matter usually C, H, O, and N. (N. C. H. O). There are however exceptions. Vegetable albumen contains Nitrogen. Fat and Sugar of milk contain no nitrogen although they are animal matters. Besides these elements, there are others occasionally present in minute quantities. In albumen there is a little Sulphur, and in the fatty matter of the brain, a minute quantity of free phosphorus. The laws of the constitution of organic substances are not well made out as the subject is very complicated. Some of the laws are illustrated in the following table but they maybe subjected to modifications.

You may smile at this statement and view it in the light of a joke, but I have put it to you as a candid physical truth. I wish to express my opinion that if you wish to indulge your humor at the expense of these halls it will be very dry humor.

Chemistry is studied under disadvantages in the Country, where the necessary experiments are not readily performed, and where the necessary apparatus and requisite materials are not easily ^{procured} ~~performed~~.

Yet some progress may be made by the zealous student even in experimenting. If you take a handful of salt petr, and put it in the end of the barrel of a gun, and then set fire to it, a peculiar kind of air will come out of the muzzle; the air is opaque, and by applying to the muzzle a piece of paper having the least spark of fire, it will instantly blaze.

Place in a glass jar with a wide mouth, a mixture of brown stone and iron filings, made into a paste with water & then closely cork the jar. The action of the mixture in the course of

- (5) Benzyle ($C_{14}H_5O_2$) and O = benzoic acid ($C_{14}H_5O_2$) O
 and H = oil of bitter almonds (C_7H_5O) H
 Ethyle [H_4O] and O = Oxide of Ethyle or Ether (H_4O) O
 and O and H = Alcohol (H_4O) O + H O
- (6) Acetone (C_3H_3O) and (Carbonic acid (CO_2) = acetic acid ($C_4H_3O_3$)
- (7) Nitric liquid ($C_4H_4Cl_2$) -- $C_4(H_3Cl)Cl_2$ -- $C_4(H_2Cl_2)Cl_2$ }
 $C_4(HCl_3)Cl_2$ -- $C_4(Cl_4)Cl_2$ = C_4Cl_6

§1. Carbo-Oxygen acids.

Acids Oxalic C_2O_3 -- Croconic C_8O_4 -- Mellitic C_4O_3

§2. Carbo-hydro-oxygen acids. 1st Subsection. Non fatty

acetic acid $C_2H_3O_3$ -- Formic acid $C_2H_3O_3$ -- Lactic acid $C_3H_5O_3$

Organic Substances are divided into 1. Organic acids, 2^d Organic bases, 3^d Organic neutral Substances, 4th Organic coloring substances. The acids are numerous, and may be divided into sections founded on their ultimate Composition, as they contain only 1st C + O, 2^d C, H + O, 3^d Contain N. 4th Some contain inorganic acids with organic matter + 5th Those which are of doubtful nature

48 hours, will be such that you will get a new air. If you remove
 the cork and put an inflamed piece of paper in, the flame will
 be extinguished. Mix dilute oil of vitriol on small portions of iron
 on tacks in a mineral water bottle, and put in a cork perforated
 by the stem of a tobacco pipe, an air will be obtained which will
 take fire on the application of flame and burn like a faint
 taper. If you place over this faint flame, a glass tube, it will
 become covered on the inside with little drops of water, proving
 that the substance formed from the Combustion is water. In this
 Experiment if you are too hasty in applying fire, you will have an
 explosion. This does no harm, & the offense you blow yourselves up, the
 better, provided you are not hurt, for such occurrences serve to impress
 important scientific facts upon your memory. Having for the first 18 mos
 studied anatomy, materia medica, & chemistry, the student is prepared to
 reap greater advantage from the 1st full course of public lectures. Here
 he completes his anatomy, learns the laws of vital action in health,
 investigates the same laws in disease, finishes his knowledge of Materia
 Medica, & by studying the action of these articles, brings into requisition

and are called doubtful acids. 1st Carbo-oxygen acids. There are three, oxalic, Croconic, and mellitic acids. The principal acid oxalic acid exists in sorrel and other plants combined with potassa or lime. It is made by acting on Starch or Sugar with 6 times its weight of Nitric Acid. It is a white crystalline acid, and is a rapid poison. It is often mistaken for Epsom Salts. The antidote is Carbonate of Lime. There are three potassa oxalates, a monoxalate, a binoxalate, and a quadroxalate of potassa. Oxalate of ammonia is used in solution to detect lime.

2nd. Carbo-hydro-oxygen-acids. This Class is divided into 2 Sections 1st Non fatty acids, and 2nd Fatty acids of this Composition. 1st Non fatty acids. Acetic acid is diluted^{as} vinegar which contains other substances in small proportions to give taste and color. Acetous fermentation is superinduced in a liquid that has undergone the vinous fermentation, at a temperature of 80° or 85° freely exposed to

the knowledge he has acquired, & in this way reap benefit from the teachings
 of the professors in the various branches of practice of surgery, obstetrics etc, & in
 the course of his medical instruction learns the uses of animal & vegetable substances
 I now speak of the medical student who cannot take more
 than 2 courses. Both the courses must be full courses, & under these circumstances
 I advocate private instruction for 18 mos & that the student learn as much as possible
 in that time. Still making the 1st course a full course has its disadvantages
 which even a careful previous study of 18 mos. cannot balance. For in a full
 course the elementary & superior branches are listened to promiscuously in
 the same day, and unless the student is diligent and very careful, he is
 apt to have a clouded notion of what he hears & confound the different
 branches. He should learn to separate the principles of medicine as a
 science, and their application as an art. I now come to the case where the student
 can attend sessions at a medical university. In this case still requiring
 that he begins his studies in the spring, he should prepare himself as carefully
 as he can during 6 mos, & repairing to college should take the 1st winter, a
 practical course, embracing the more elementary branches, anatomy, materia
 medica & chemistry, the 2 subsequent courses should be full courses, and the

air. In France wine is used for this purpose; in England, malt; and in the United States, they use Cider. When perfectly pure, it is white like water, but at the same time it is weakened in strength. Vinegar and the distilled vinegar are very dilute solutions of acetic acid. To get a strong solution, decompose an acetate, by means of some strong acid. Pour H_2SO_4 on an acetate of Soda and distill the acetic acid over. You thus get *Acidum Aceticum* of the U.S. pharmacopoeia. When it is an acetate of water it may be obtained strongest. At a temperature of 40° ice solidifies it. The great source of acetic acid is impure Sour liquid obtained when wood is subjected to destructive distillation. This is full of tar and is called crude pyroligneous acid. It has a tarry smell. Saturating this with carbonate of Lime, you get acetate of Lime; decomposing this with Sulphate of Soda, you get acetate of Soda.

Elementary branches are heard of times, and the principal branches twice.
 When a student has arrived at the place where he attends lectures, he is for
 the ¹st time alone & dependant on himself, & should proceed to suit himself in a
 residence. In a large city he is surrounded with numerous temptations, in relation to
 which, to be forewarned, is to be forearmed. His ¹st care should be the preservation of his
 health, sickness independently of danger is attended with debility & consequent loss
 of time. It is a mistake to get a boarding house near the college, since a considerable
 walk will form a good sort of exercise. All plans necessary to protection against the
 inclemency of the weather should be provided and care should be taken not to
 sit in wet feet or clothes. If you are not sufficiently protected against small pox
 you should be immediately vaccinated, for the danger of contracting this disease
 is much greater in cities than in rural districts. The next thing is to make a proper
 regulation of the heat of your room, it is often badly ventilated & kept too warm, the
 temperature should never exceed 70° & if the room be used as a sleeping apartment
 the fire should be allowed to go down, & places for ventilation should be made
 before retiring to rest. It is not advantageous to have a room mate, for no matter
 how congenial in dispositions, no two persons occupying the same apartment, are likely
 to be disposed on all occasions, to read & write at the same time, & if they do not do so

Act on this with Sulphuric acid and distill the acetic acid which comes over. Pure acetate of Soda is a white salt & is not deliquescent. Acetate of potassa may be obtained by treating acetic acid with a compound containing potassa. This is very deliquescent. A solution of acetate of ammonia is made by adding to distilled acetic acid, Carbonate of ammonia. This is officinal as *Liquor ammonia Acetatum*. Distilled vinegar is not pure. *Acidum Aceticum* must be 104° and diluted with 7 times its weight of water and then it is of the officinal strength. Acetate of lime when distilled furnishes acetone. Acetate of protoxide of lead is Sugar of lead. It has a sweetish astringent taste & is slightly efflorescent. Make a solution in water and heat it, it will dissolve a good deal of litharge and this will make Goulard's extract of lead which is officinal. *Liquor plumbi-sub-acetatis*, always in water. Sugar of lead is officinal as

they will disturb one another. Solitary study is to be preferred, as likely to be more continuous & more productive of improvement. The subject of books is important; students are sometimes too eager to accumulate books which perhaps they may never read. A student's library should consist of scientific dictionaries, & such scientific works on medicine as have copious indices, as are to be consulted, rather than be perused. Then he can add from time to time other works of a character that deserve a careful perusal. It is a good rule for the student not to indulge himself with a new book of this kind, until the one in hand is fairly read, and thus a habit of systematic reading is engendered, & the discouraging knowledge is avoided of possessing too many unread books. After graduation several medical periodicals may be taken with advantage, but should be skimmed rather than regularly read. The thesis of candidates for the degree of M. D. is important & not sufficiently attended to. The proper period for beginning is the Spring before graduating. If the essay is an experimental one, so much the better. The Spring will give him ample time to prepare a sketch or rough draft of the heads of his inaugural address, & successive copying will improve its style & make it more professional. Many fail to do this simply because they have it too long & commence it when they must pay strict attention to their last course of lectures, and their minds are

Plumbi Acetatis. Add to a pint of water, two drachms
 of *Liquor plumbi-sub-acetatis*, you form the proper
 lead water officinal as *Liquor Plumbi Subacetatis*
 diluted. Acetate of protoxide of zinc is made by
 adding to acetate of potash a sulphate of protoxide
 of zinc. It is officinal and in solution is used as an
 injection in Gonorrhoea. The Pharmacopoeias differ
 in their formulas for its manufacture. There are
 acetates formed from Copper. Verdigris & distilled Verdi-
 gris. Verdigris is made by stratifying sheet copper with
 refuse grapes after making wine. Vinous fermentation
 forms a Sub-acetate. It is used to form an officinal
 ointment. The Crystals of Venus, are distilled neutral
 verdigris. Formic & lactic acid exist in milk and
 in many secretions of the body. Lactic acid is formed
 during the souring of milk and the fermentation of
 milk juice.

LXIV. Acids Oxalic $\text{HO}(\text{C}_2\text{O}_3)$ - Acetic $\text{HO}(\text{C}_4\text{H}_3\text{O}_3)$
 Formic $\text{HO}(\text{C}_2\text{H}_3\text{O}_3)$ Lactic $\text{HO}(\text{C}_6\text{H}_5\text{O}_3)$

filled with anxiety concerning the approaching examination & it is sometimes composed and written in a slovenly manner, the red lines in the paper being often transgressed and even written upon; the writing in some cases cannot be dignified by the name of handwriting, since it does not look as if it had been performed by the hand, but rather looks as if it had been scratched by Harriet Beecher Stowe, or somebody else's toe. You may laugh if you will, but legible writing is important. You have all heard of the instance in which *qua potis* written in a prescription was taken for *potis* & nitric acid substituted for spring water. It is not more than 20 years since I was guilty of a piece of carelessness which I can never look back to, without mortification. I wrote an order for the application of leeches in a case of Dyspepsia, the order was written so badly the leeches were applied to a wrong part; therefore clear writing is very important, and ever since, attaching much importance to improvement in this accomplishment, I have endeavored to improve my handwriting and with some success. It must be manifest that it is the business of medical men to study anatomy & the laws of vital forces, & the modifying influence of these forces exerted by material substances & the importance of anatomy as a basis of physiology & chemistry. The impoisonables as remedial agents are highly worthy of investigation, if the student does not attend properly to the lectures, we cannot give them the

Tartaric acid \underline{I} $\text{HO}(\text{C}_4\text{H}_2\text{O}_5)$

KO, I and CaCl - CaO, I and KCl

Potassa Bitartaras $\underline{\text{US}}$ $\text{KO}, 2\text{I}$ - Potassa Tartaras $\underline{\text{US}}$ KO, I

Soda et Potassa Tartaras $\underline{\text{US}}$ $\text{KO}, \text{I} + \text{NaO}, \text{I}$

Ferri et Potassa Tartaras $\underline{\text{US}}$ $\text{KO}, \text{I} + \text{Fe}_2\text{O}_3, \text{I}$

Antimonii et Potassa Tartaras $\underline{\text{US}}$ (Lactar smetic) $\text{KO}, \text{I} + \text{SbO}_3, \text{I} + 2\text{HO}$

$\text{KO}, \text{I} + \text{SbO}_3, \text{I} + 2\text{HO}$

Tartaric acid is obtained from the Crust forming on the inside of Casks where wine is maturing. It is sometimes of a reddish brown color & sometimes white. It is Called argol, and Contains potassa united with a vegetable acid called Tartaric acid because the substance is often called Tartar, and according to its Chemical Composition it is Called Bitartrate of Potassa. This Can be decomposed so as to yield the Tartaric acid Separately. Crude tartar is purified to obtain crystals of Tartar and when powdered these form Cream of Tartar. Adding a Solution of Bitartrate of Potassa to Lactonate of Lime, Carbonic

Systematic examination which their importance so justly demands. While speak-
 ing of impossibilities, allow me, gentlemen, to indulge in a digression in relation to the
 electric telegraph. The connection between England & France is well known, and a similar
 connection between Europe & Africa across the Mediterranean, will form a connection
 between our most distant territories. A project has been commenced to make a telegraph
 in connection from Dublin Newfoundland to Valencia, passing on the S.W. coast of Ireland
 to connect the old with the new world, a distance of 1140 miles. & the only serious diffi-
 culty is in the enormous length of cable required. The bottom of the shore between these
 points for near three 1000 miles, has been found to be a level plain at the depth of 2 miles
 and to consist of several materials especially adapted to form a bed for such a cable.
 I have no doubt this noble enterprise will be crowned with success. It is a plan which will
 place us in immediate connection with India & China, & it is not predictive more than has
 been accomplished to say, that the day will come when the electric band will be found
 stretched from the Atlantic to the Pacific, to the shores of California & across the ocean to
 the place of beginning & there will be accomplished the highest flight of fancy of the
 painter of dramatic poets when he says, "I will have a globe round about the earth
 in 40 minutes. Let us turn our attention to the study of ponderables. Chemistry teaches
 the intimate nature of these substances, & deduces the laws of their action. Fixing your

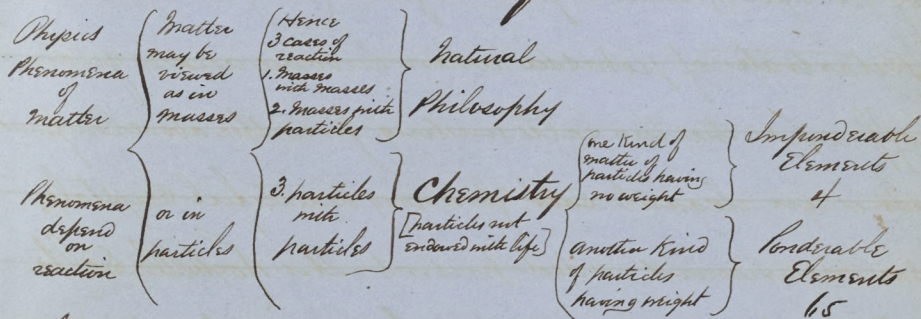
acid is given off, and one equivalent of Tartaric acid forms with Lime, a Tartrate of Lime. The remainder is monotartrate of Potassa, which may be Converted into Tartrate of Lime by adding a solution of the Chloride of Calcium and the remaining product in solution is a chloride of Potassium. Acting on Tartrate of lime with Sulphuric acid, Sulphate of Lime is formed which precipitates and Tartaric acid is set free. By Concentrating this & allowing it to Cool it will crystallize. The crystals are reduced to a fine powder, by the apothecary so as better to dispense it. It is Soluble in water and in alcohol, and has an acid taste refreshing when largely diluted with water. It is used to make Soda powders with carbonate of Soda in one paper and Tartaric acid in another. There are several tartrates which are important medicines. There is a Bitartrate, and a mono-tartrate of potassa, Tartrate of Soda & potassa and several others. Bitartrate of potassa is the Argall's purified from coloring matter &c

master these laws, you will be prepared to apply analysis to every animal part
 whether in health or disease, to every material substance as a remedy. Chemical
 analysis is important to physiology, for the chemical examinations of the art of medicine,
 teach us the effects of these combinations as remedies, that we may know their action in
 diseases. It would be a vain attempt on the part of an instructor in a lecture to enu-
 merate all the applications of chemistry to the different departments of medicine
 & the student should have at least a knowledge of the chemical relations of atmos-
 phere & water. In many instances of disease the instruments are furnished by chemis-
 try & the treatment dictated by chemical principles. In urinary & calculous
 diseases, it teaches us the cure, dictates the proper doses & furnishes us with many
 antidotes for poison. It is hardly impossible to teach chemistry in an introductory
 lecture. All I can hope to accomplish on an occasion like the present, is to con-
 vince you of the importance of chemical knowledge to the medical practitioner.
 If I have succeeded in doing this, you will have received a favorable impression for making
 a good beginning, & your own feelings will tell you to enter on its study with a firm
 determination to master its principles. In conclusion, gentlemen, let me remind
 you of the heavy responsibility of the profession you are approaching. It is one which
 should be undertaken with zeal, and a firm desire to exert your utmost efforts

by dissolving it in boiling water, straining & allowing
it to cool. The crystals are reduced to powder, when it
is called Cream of Tartar which is soluble in cold &
still more so in boiling water. It is insoluble in
alcohol and this is the main reason of its primary
deposits on the sides of the wine Casks. Mono Tartrate
of potassa is a neutral tartrate and is made by saturat-
ing a hot solution of carbonate of potassa by the Bi-
tartrate of Potassa, when the Carbonic acid is given
off and the neutral tartrate is formed. This is called
soluble tartar. It is a valuable purgative. Tartrate
of potassa & Soda is formed from carbonate of Soda, &
Bitartrate of potassa when carbonic acid is given
off and the two salts uniting form the above Compound.
It is an elegant salt, forming beautiful crystals
in numerous sided prisms. It is Rochelle Salt.
Tartrate of potassa and Sesquioxide of iron
is formed by making a Sesquioxide of iron and

in a noble cause. First, be sure your predilection is to the medical profession, and then study diligently & judiciously. When you receive the highest medical honours as a reward for your successful studies, you are deemed Competent to begin your career as practitioners; you are not so Competent as you may become if you pursue your studies as it is your duty to do; by reading, observation &c, your mind will become more and more stored with medical truths, and your knowledge will increase to old age, if life & health be spared you. And sooner or later the inevitable change must come, and when it approaches, it is my fervent prayer, that you may have the precious Consolation of looking back upon a well spent life.

Chemistry



Chemistry treats of the reaction between particles

Chemistry treats of the attraction or repulsion between particles whether ponderable or impendurable

Chemistry treats of attraction between ponderable particles
and repulsion between impendurable particles

Material Substances exhibit certain phenomena or appearances, the investigation of which constitutes the science of Physics. These phenomena depend on reaction which means the effect one particle of matter has on another. Physics is that branch of knowledge which investigates the reaction of matter upon matter & is a very comprehensive science. For its convenient study we find it divided into 2 departments Natural Philosophy & Chemistry which are the 2 branches of the Science of Physics. When we subject matter as an object of our senses, we find it presented either in lumps or aggregates consisting of many particles held together by a certain force, or we find it presented to us in many particles not aggregated but having a tendency to fly asunder. The lumps are technically called masses, & the minute particles whether collected into lumps or if they be endowed with a tendency to fly asunder are called particles. In this division of matter there are 3 cases of reaction established by bringing the changes upon reaction. The 1st is where the reaction is of masses with masses and is where it takes place between masses & particles & 3^d where it is a reaction between particles & particles exclusively. We will investigate the whole subject of Physics or the Science of Matter as considered in these 3 cases of reaction. This belongs to the department of Natural Philosophy & the phenomena arising

out of the reaction of particles & particles belongs to Chemistry. Chemistry is the Science which treats of the reaction of particles, which must not be endowed with life. If then the reactions are carried out of Chemistry it is because they are endowed with life. The 2 essential properties of matter are Extension & impenetrability. Impenetrability is here used in the Scientific sense, signifying that no 2 particles can occupy the same space at the same moment of time. The non-essential properties of matter are very numerous, such as opacity, transparency, hardness, color, compressibility, expansibility, elasticity &c. Without any of these properties matter may exist. Matter is divided into masses & particles, but not only so, also as it has weight or has no weight. The kind of matter consisting of particles having no weight, is called imponderable matter & the other kind is called ponderable matter. We can say Chemistry treats of the reaction of particles whether they are ponderable or imponderable. Reaction may be divided into 2 classes, it may be evinced or manifested in making the particles of matter approach & when it is manifested in this way we call it attractive reaction, but we discard this Circumlocution & call it attraction. When the particles manifest a disposition to fly asunder, it is repulsive action & we call them repulsive particles. Particles are not endowed

with both of these powers. There are one set of particles which have mutual attraction for each other & one set which have a mutual repulsion against each other & thus we can enlarge our definition of Chemistry. Indestructibility is not strictly essential or not essential. Imponderable matter consists of 4 different sorts called imponderable particles; they are light, heat, electricity & magnetism. The ponderable particles are of 16 different sorts, 13 of these ordinary elements are non-metallic & 3 are metallic.

Attraction & repulsion are evidently essential properties of matter.

Any course of Chemistry will be divided into 4 grand divisions. 1st. Repulsion 2nd Imponderable particles which manifest repulsion, 3rd. Attraction between ponderable particles, which will introduce the 4th head; ponderable particles.

71 1st. Repulsion, we know little about it & its laws. Imponderable particles have an attraction for ponderable matter. 2. Imponderable bodies are those whose particles exercise repulsion. Light will be skipped over as belonging to Natural Philosophy. Heat, or Caloric will be considered under 3 heads 1st changes by which it is put in motion 2 The different modes by which Caloric gets in rest after having been put in motion 3 The state of Caloric which the body has taken when this

state of rest has been reached & the changes produced in imponderable matter
 by caloric & the instruments employed to measure the intensity of
 caloric. ^{1st} Caloric must be put in motion, if not, we would know nothing
 of its existence so essential is motion to the phenomena produced by it
 whatever changes the capacity of a ponderable for heat will set caloric
 in motion. All ponderables contain heat, when heat among any number of
 ponderable bodies is in a state of rest, of the same temperature, the differ-
 ent ponderable bodies will have a different share of Caloric, although of the
 same temperature. The relative quantities of absolute Caloric existing in
 bodies is different. Every body has a power which will set Caloric in motion.
 The change must be in the direction either of decrease or of increase
 when a body suffers a decrease in its capacity Caloric will flow out & you
 will have sensible heat. This is motion of Caloric in an outward direc-
 tion. We can arrange this under 2 heads Condensation & Certain chemical
 changes. Under the latter we arrange Combustion the ordinary Combustion
 where there is a burner & supporter. There are other forms which have less
 capacity for Caloric than the mean capacity of the Combuster & the
 supporter & the Caloric must be squeezed out. When we mix things
 together there is a reaction. The Capacity for Caloric being increased

the reverse takes place. Cold is produced or a diminution of temperature. There are four 2nd kind. Dilatants & certain chemical changes. If cold is produced in a body, Caloric will flow in.

III There are 3 ways in which caloric may be in a state of rest, 1st by Radiation 2nd by Conduction 3rd by Concretion. Radiation is one way in which Caloric tends to a state of rest, when shot out with great facility the caloric is shot out in all directions, but mostly perpendicularly, & this heat is called radiant heat. The rate at which radiation takes place, the temperature of the heated body being given, depends upon the nature of the body which radiates & upon the nature & color of the surface. Different bodies radiate differently. A plane surface of copper will radiate heat, if it be scratched, it will radiate more & still more, if it is colored black. Heat is either transmitted through matter, reflected from it or absorbed by it, or it may be partly absorbed, reflected, & transmitted. Conduction is applicable to solids, it is the sole way in which Caloric disposes itself when tending to a state of rest, & heat is propagated which may be easily measured, the particles nearest the source of heat take heat & give it again to particles more remote. There is a limit to the conducting power of a solid, which

is the temperature at which it melts. Solids vary in their conducting power. Metals are the best conductors of heat. Glass, wood, charcoal &c are improper conductors of heat. The best are gold, silver, copper, platinum, iron, zinc, tin, & lead; next, brick & pottery; next, at a long interval, glass, wood, & charcoal, & at another long interval silk, cotton & wool. Ice down is the worst conductor there is. Water is a poor conductor, though it requires nice experiments to prove it. Fluids are heated by convection. To distribute the heat, it must be applied to the bottom of the liquid, & there are currents made in the liquid from the source of heat, and towards the source of heat. The currents continue until the water boils. The steam formed at the bottom will bubble up & produce ebullition; air is heated by contact with the heating source.

IV Considerable bodies of the same temperature do not contain the same amount of heat. We have standards for the different capacity of bodies to contain heat. The capacity of water we call 1 and it is the standard; we assume the capacity of air to be 1 for the comparison of gases & vapors. The capacity of oil is .5. The changes produced in

ponderable matter by heat are divided into 2 heads, 1st changes produced in bulk or volume 2^d change of the state of aggregation. Change in aggregation may be either in the solid, liquid or aëiform state. There may be change in bulk, where there is no change in the state of aggregation. The general law is that Caloric will increase the bulk least in solids, & most in gases. Different solids expand different degrees at the same temperature & the same solid expands in an increased ratio as the temperature rises. Metals expand more than other solids in the following ratio, Zinc, Lead, Tin, Copper, iron, platinum. Liquids expand more than solids. The boiling point of water is 212° , alcohol 176° mercury 686° . The more a liquid is found to expand while still liquid, the lower is its boiling point. Oils expand more than liquids. The expansion of gases by heat is perfectly uniform, & expands the same at a higher or lower rate of temperature. Gas will expand $\frac{1}{492}$ part of its bulk for each at the freezing point, for every degree of temperature it receives. There are some exceptions to the general rule, Alumina, or pure clay, will contract in the fire; there is a tendency to pack the particles closer together. Certain crystals expand by heat, & this anomaly has not been explained, they expand on some surfaces & contract on others. Water under the tempera-

ature of 39° will contract by heat. There is an actual density of water about the temperature of 39° . Its freezing point is 32° . The deeper water is, the harder it is to freeze.

V Changes are produced by Caloric in the State of aggregation. Sulphur at ordinary temperature is a solid if we give it heat to the temperature of 220° it melts, and at 570° it forms a vapor or gas. Water is a liquid at common temperatures, deprive it of caloric at 32° it becomes ice, & by giving it Caloric at 212° it becomes Steam or gas. Sulphuric acid at common temperatures is a gas, Cool it to 40° below zero under a pressure of 26 atmospheres it becomes a liquid, & still further at 80° below zero it becomes a solid. Some gases have not yet succumbed to cold & pressure. This Subject is divided into 2 heads, the Change from Solid to liquid & back again & from liquids to gases & back again. In relation of caloric to probable matter melting is only modified so that the temperature remains constant during the change, notwithstanding Caloric is received & lost during the Engendering of liquids. When ice melts it receives Caloric during the melting; the particles do not increase in temperature though they receive Caloric; the particles undergo a compensating increase of Capacity which would have depressed the temperature of itself. When water freezes the particles of water are suddenly decreased without any diminution of temperature. The reason is there is

simultaneously going on during the process, a compensating decrease of capacity which acting alone would have raised the temperature as much as the loss of Caloric if acting alone would alter the temperature. The temperature disappearing on the mixture of water & ice is said to be latent heat but I don't like the expression. The same is true with regard to the changes between liquids & vapors; in the latter case the change of capacity is much greater, but this does not alter the principle. The point of the change of the state of aggregation of liquids into vapors is called the boiling point & takes place at different temperatures. In turning solids into liquids, the only force to be overcome is cohesion; in liquids, cohesion, gravity & pressure of the atmosphere. In the change from solids into liquids, there is a general increase of bulk. There are 3 exceptions, cast iron on melting, antimony on melting, & ice on melting. The boiling point is lowered by diminishing the pressure of the atmosphere; & increasing the pressure raises the boiling point. When the atmosphere is very dense the boiling point is raised. The range according to the extremes of the barometer is about 5° . The temperature at which a substance as water will boil in vacuum is 140° less than the boiling point at the common temperature.

[XV] At the boiling point of any liquid the elastic force will overcome the pressure of the atmosphere that attempts to keep it down.

The elastic force of vapor depends upon the temperature & will not be so great if the pressure of the atmosphere be less: When steam is formed in contact with the water furnishing the materials for its formation, it becomes more dense as the temperature is increased & therefore the elasticity of such steam depends on two circumstances. 1st. Increase of temperature progressively; which by itself would make the steam more elastic & 2nd. More & more steam is packed into the same space, & thus causes increased elasticity. Elasticity depends upon the 1st independently of the 2nd. There is an important law connected with the converting of liquids into vapors, or the process of distillation. This curious law is the same of all vapors no matter what their density, namely, That they always contain the same quantity of absolute heat; for the heat of temperature & heat of capacity added together always produces the same sum. This law has an important bearing on the subject of distillation. If you distil under a diminished pressure of atmosphere, you distil at a lower temperature for the boiling will take place at a lower temperature. When this was first discovered the artizan thought he could save fuel by distilling under diminished temperature, but this does not economise the fuel. It is useful under certain circumstances to distil in this manner, as when you manufacture fine sugar, & in forming medicinal extracts, which are

so important to the physician which should always be distilled under diminished pressure, so as to be prepared without being burned by which their efficacy would be impaired. There are instruments employed for measuring the intensity of heat, called thermometers for low & medium temperatures, & pyrometers which give the approximate temperatures of furnaces & fires. The indication of these instruments depends upon the general effect that expansion is suffered by ponderable matter by the influence of temperature. The state of aggregation employed in these instruments is various & runs through 3 states of aggregation. Liquids indicate common temperatures, air, slight variations, & Solids are used at very high temperatures. Thermometrical substances are either liquids, gases, or solids. Only 2 liquids are now employed in thermometers, mercury & alcohol. Mercury is the best thermometrical liquid, as it has a low freezing & a high boiling point, & because it is a good conductor of heat. In forming thermometers of liquids, we have two fixed points which all philosophers have agreed on as the fixed points in all ordinary thermometers. These are the freezing & boiling point of water. These substances are contained in a glass tube furnished with a bulb at its lower extremity. The intervals between the fixed points is divided differently, according to the fancy of different persons. Reaumur's thermometer is divided into

80 degrees. Celsius divides it into 100 equal parts & in Fahrenheit's thermometer it is divided into 180 equal parts. In Raumer's & the Centigrade or Celsius's thermometer the zero is placed at the freezing point; & in Fahrenheit's 32° is placed at the freezing point, so that the boiling point comes to 212° . Another thermometer was formerly used in Russia where the interval was 150 equal parts, & zero was at the boiling point, & the progression was in a downward direction toward Cold. The Centigrade is the most scientific thermometer on account of the even number of parts into which it is divided. A mercurial thermometer must not be graduated to its full extent, for it forms an elastic vapor before it boils which may have sufficient force to burst the tube which is always hermetically sealed. Though it boils at 656° it is not prudent to graduate a mercurial thermometer higher than 630° . You cannot graduate it lower than 39° below zero, for at that temperature it congeals or freezes. When we want to examine a temperature lower than 39° below zero, we must take pure alcohol which is usually colored by Carmine to make it more obvious to the eye. Some of these are graduated to 190° below zero. There is also a self registering thermometer, intended to mark the highest & lowest temperatures reached during the 24 hours during the absence of the observer. It consists of 2 thermometers the stems of each

being turned at right angles from the bulb, & form 2 parallel stems of glass. The lower one is of mercury & has a piece of steel resting upon the top of the mercury. As the mercury rises it pushes the steel up & when it has reached its highest point as the temperature diminishes it retreats but the piece of steel remains at the highest point to which it was pushed & thus its lower edge indicates the highest temperature reached. The other is an alcoholic thermometer which will indicate the lowest temperature reached. In it there is a piece of black enamel or glass immersed in the liquid, & as the cold makes the alcohol go back, the piece of enamel is sucked back as the temperature falls, & when there is an increase, the alcohol retreats but leaves the enamel where it was. In many pharmaceutical operations we desire to apply a boiling water temperature & no higher which might burn the product we wish to preserve & apply. Now we must use the water bath so called, for water cannot boil at a higher or lower temperature than 212° . Air is a thermometrical substance employed only for very slight variations, and if it were not that its expansion depended upon the pressure to which it is subjected as well as upon the temperature, it would be a most perfect thermometer. If the temperature remains the same & the pressure is diminished a certain portion of air will expand. The best air

thermometer is the differential thermometer. The Solid thermometer is formed of clay which will get smaller in the fire. It is of a flat cylindrical form.

There is a piece of bridge wood having two grooves which taper the sides of which are graduated to 200 equal parts. The pieces of clay are arranged to fit in the groove at the widest part. The clay is put in the fire & gets its temperature, it is then taken out contracted & is pushed into the groove until it gets jammed, & the graduations at the side give the temperature.

The thermometer I have is divided into 204 parts; the beginning is 1077° of Fahrenheit's thermometer & each degree is 130° . Another thermometer of this kind consists of slips of silver & platinum soldered together by gold & furnished with an index which serves as a graduated scale.

VII. The indications of the different sorts of thermometers can be changed, one to the other. The equivalent degrees are 100, 80, & 180, which can be brought down to 5, 4, & 9. Therefore there is an equation formed as follows, in changing the degree of Celsius's thermometer to that of Fahrenheit $5:9::$ Centigrade : Fahrenheit, & in the other case $4:9::$ Reaumur : Fahrenheit, & the equation is the reverse to form a change from Fahrenheit to Centigrade or Reaumur, always adding or subtracting as the case may require from 32° because the zero of the other thermometers corresponds to 32° of Fahrenheit.

Electricity is the third ~~ponderable~~ imponderable. When certain
 Substances are rubbed, they are found to acquire a peculiar property of attracting
 light bodies, which after being attracted, are then repelled. This is attributed to the
 movement of a peculiar imponderable Substance Called Electricity. This is assumed
 to be present in all bodies, & when it is in a state of rest exhibits no properties what-
 ever. When its Equilibrium is disturbed the Electricity is said to be excited, & the
 ponderable body which is disturbed, is said to be electrified. Electricity may be
 excited by chemical agency & by heat. When Electrical excitement is produced by friction, it
 is called Simple Electricity, & when excited by chemical agency, it is Called galvanism,
 & when excited by heat is called thermo-electricity. When Electricity is produced by
 friction or contact it is Common Electricity. In some cases when excited by friction, it is
 merely momentary disappearing the instant it is produced, on account of the Communication
 between the bodies rubbed & the earth. When other substances are rubbed the excitement is
 comparatively permanent, because the nature of the Substance is such as not to give an
 easy passage of the excitement to the earth. The solids which can only be temporarily
 electrically excited are said to be Conductors & those which can be permanently
 excited are said to be Non-Conductors. Metals as a class & charcoal are Conductors,
 the conductors are called non-electrics, & the nonconductors are said to be electrics.
 Conductors may be made electric, by placing between them & the earth, an

Electric, & thereby cutting off the Communication between the Conductor & the Earth,
 & giving no passage to the Electricity excited in the Conductor; Such conductors are said to
 be insulated, & therefore become temporarily Electric. In rubbing Electrics the kind of ex-
 citement manifested is not always the same. The two kinds of Electricity produced, have
 been called vitreous & resinous Electricity. If when two substances are rubbed, the electric-
 ity produced is alike, the light bodies will repel each other, & if dissimilar they will at-
 tract each other. The same body will become resinous or vitreous according to the nature
 of the body by which it is rubbed. The fur on the back of a Cat is the substance most prone
 to be vitreously electrified, & Sulphur is most prone to be resinously electrified. The
 theory of the vitreous & resinous Electricity was first advanced by Dupuy & is called Dupuy's
 theory. Later Symmer said that all bodies contained each kind of Electricity & by
 friction, according to circumstances either resinous or vitreous Electricity was con-
 veyed from one body to another. Franklin argued there was only one kind of
 Electricity. He alleged that at all times ponderable substances had their natural
 quantity of Electricity, & that when two bodies were rubbed together, one parted
 with a portion of its Electricity which was received by the other. The overcharged
 state he called positive Electricity & designated by + & the undercharged state
 he called negative & designated by -. The Vitreous Electricity of Dupuy corresponded to the
 positive of Franklin. Symmer's theory is used on the European Continent, &

Franklin is the standard in England & America.

VIII.

Glass is the most convenient electric & is combined in some mechanical contrivance for purposes of Electricity. It is generally made use of in two shapes, 1st as a disc or flat round plate & with its appropriate mechanical arrangement is called a plate machine. Another form is the cylindrical machine where the glass is in the form of a hollow cylinder. It must have a mechanical contrivance to rub it which is generally by a cushion fastened against it & the Cause of Excitement is increased by placing an amalgam of zinc upon the cushion. The electrical excitement produced can be confined in an insulated Conductor called the prime Conductor of Electrical machines. The approach of an electrified body to another body will Cause electricity which will temporarily electrify the two bodies from the influence the electrified body has upon the unexcited body. This Subject is divided into 2 kinds. 1st the effect of the approach of a positively electrified body in producing electrical excitement & 2nd the effect of the approach of a negatively electrified body in producing electrical excitement. The End of a body approached by a positively electrified body becomes negatively electrified & the opposite end becomes positively excited, & the result in the opposite case is therefore the reverse. In these Cases the Electricity is said to be

induced, & the bodies are said to be electrified by induction, & the body producing the induction is said to be the inductor. If the body which is electrified is insulated, the electricity will remain in the body instead of parting with its electricity to the Earth as would be the case before insulation. Induction always produces unlike electricity in the parts which are nearest each other. Induction is produced through a layer of air which is to some extent an electric. The most important instrument used by the electrician is the Leyden jar so called from the place in which it was first used. If you electrify the inside of a glass bottle by positive electricity you electrify numerous points on that surface & the corresponding point on the outside surface loses as much electricity as the inside gains & to save the trouble of electrifying each point in the glass, electricians cover the inside surface to a certain height & the outside surface to the same height with a thin metallic layer, that the electricity given to it may be equally diffused on the inner surface of the glass, & there is an equal spreading of the deficiency caused by induction on the outside of the glass. By making a communication between the inside & outside we can discharge the electric which is done by a discharge. A human being can be made a temporary electric by insulating him.

IX. In the Leyden jar there is an induction of electricity, & through glass as an electric. An insulated jar can be charged on the inside surface where there is a passage to the electricity on the outside. The quantity of electricity means the absolute amount distributed; by intensity the relation of the quantity to the place which the electricity occupies; the intensity of electricity is greatest when the greatest amount of electricity is deposited; it means density or the degree in which the electricity is packed. Points receive & impart electricity gradually & silently, knobs or blunt bodies pass off & receive electricity suddenly & with a snap & spark. Franklin first observed this difference, & conceived the lightning rod for the purpose of protecting buildings from strokes of lightning. Friction electricity is electricity on the surface of the bodies electrified. The estimated velocity of electricity according to Wheatstone of London 1830 is 280 000 miles in a second. If the lightning rod attached to the house is imperfect it will set fire to whatever combustible material may be within.

X. Electricity formed by chemical action is called galvanic electricity & treats of electrical phenomena produced by subjecting different substances to chemical agents. It may be produced by Copper & zinc with some Saline Solution. In ordinary galvanic

arrangements we have two solids acted upon by one chemical agent. We generally employ two of the metals, & the chemical agent is selected from the dilute mineral acids. Copper & zinc are generally selected for the metallic solids, & dilute oil of vitriol for the chemical agent.

The simplest galvanic arrangement called the galvanic circle, consists of a glass vessel containing some dilute oil of vitriol, & a piece of zinc & a piece of copper immersed in the liquid. By the action of the dilute sulphuric acid on the zinc electricity is evolved & is attracted through the liquid and accumulates in the copper. The accumulation of electricity will not return through the liquid, but may be carried off by having a good conductor passing from the copper to the zinc, & such a conductor is a metallic wire; & there is then a circular current of electricity established & therefore can be no accumulation anywhere. It is best to have two wires, one on the copper & one on the zinc. The same effect is produced by the approximation of the extremities of the metals outside of the liquid. The manner in which the electricity travels is called the circuit, when the wires are attached it is said to be closed, & when they are separated it is said to be interrupted. During the

action, Electricity is evolved as a product of the chemical action,
 & the chemical action evolving the electricity is a finite force, & the
 accumulation of electricity in the Copper plate, merely takes place as an
 arresting force to the chemical force, & when these two forces are equal,
 chemical action ceases. The best arrangements are of such metals
 that one of these selected will be acted upon by the chemical agent you
 employ, & the other will not be acted upon by it. The metal acted upon
 by the chemical agent is called the generating plate, & the other
 plate not acted upon is called the Conducting metal. The quantity of
 electricity evolved will be proportionate to the amount of chemical action
 which depend upon the amount of the generating plate immersed in
 the liquid. The intensity is the projectile force. By a connection
 of a number of simple galvanic circles by a metallic connection,
 the force of the action will be much increased & made highly useful.
 This connection forms what is called a galvanic battery of which
 there are several different complications. In the simple circle
 part of the electricity is lost on that side of the zinc not near
 the copper; to prevent this the design has been conceived of putting
 the zinc plate in a copper vessel, & the action is the same &

evolves electricity on all sides of the zinc, all of which surface is equally opposed to a copper surface.

[XI.] The first galvanic battery was the instrument invented by Volta whose successive circles were piled on one another. The next invented was the Crown of cups, formed of several simple circles, the copper of each glass being connected with the zinc in another tumbler. The multiplication of circles increases the propulsive force but not the quantity. Many other varieties of galvanic batteries have been invented.

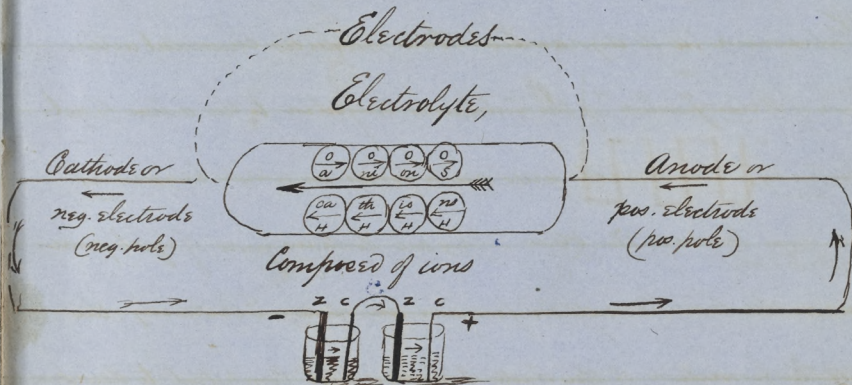
[XII.] In Swiss battery platinum is used in place of Copper. It also contains two liquids, dilute Sulphuric acid as the generating liquid & Nitric acid as the conducting liquid to be in contact with the platinum which is the conducting metal. The conducting metal must not be acted upon chemically. This is the form used for the magnetic telegraph.

There is another battery by Faraday where the conducting metal is iron the conducting liquid is equal parts of Nitric acid & Sulphuric acid & the generating liquid is, Where Volta are electrified by increasing the activity in case of deficiency & remaining in a state of rest it is called statistical electricity & there is no current used. When there is a current it is called dynamical electricity. In Common Electricity the statistical state may be produced by induction & this is called Statistical.

induction, & when current electricity is produced by induction it is called dynamical induction. Currents in the same direction attract & in contrary directions repel.

XIII. Galvanism in its dynamical state produces chemical action in the form of decomposition of the substances subjected to the action of galvanic electricity. Reciprocal forces are to forces in which beginning with one you produce the other. They are contrary forces of equal power. The action on the zinc consists in forming an oxide. Electricity, the product of the formation of the oxide of zinc, is just competent to decompose the oxide of zinc by passing through it. When the circle is interrupted the ends of a galvanic arrangement are called poles, one consisting of one end being overcharged & the ~~other~~ end being undercharged. When the circle is interrupted & you have poles you can decompose nothing. When the circle is closed & there are no poles, when there is a current & no accumulation & deficiency you can decompose different chemical compounds. The most interesting property of the Galvanic battery consists in the decomposition of materials. To decompose anything the current is closed & the object to be decomposed is made part of the communication between the different poles. This is the system used by Faraday who

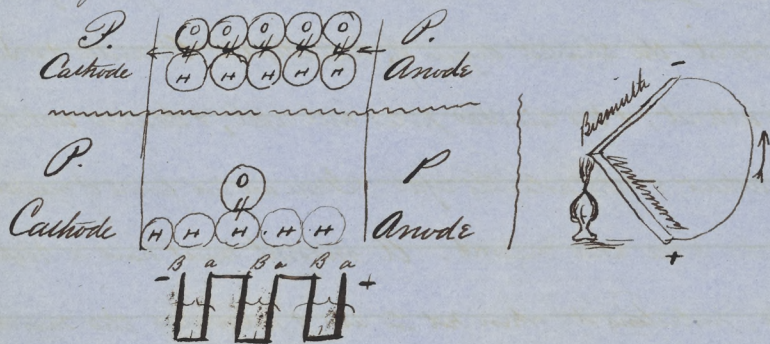
established a celebrated nomenclature. Observing the relation a current of electricity has to a compound body subjected to its decomposing influence he established his nomenclature, as evinced by the following diagram.



The electrolyte is subjected to electrolysis, & in electrolysis it is separated into two parts of the electrolyte from the other; one part goes to the Anode & the other to the Cathode, & they are both ions. Ions going to the anode are electro negative elements because they go to the end which is the positive electrode. In water as represented above the two ions are Oxygen & Hydrogen.

Thermoelectricity is electricity produced by heat, & alludes to all the phenomena of electrical disturbance which can be produced by the sole agency of heat. The first observation in this department was made by Seebeck of Berlin in 1822 who observed that if he soldered together dissimilar metals & heated the place of junction he could produce

Currents of Electricity.



Magnetism

XIV. *Galvanism* is that impenetrable possessing the peculiar property of attracting different particles of iron. Two metals *zinc* & *char*, beside *iron* exhibit magnetic properties but very feeble.

A natural magnet exists in the so called *lodestone*. Of all the forms of iron for magnetic purposes *steel* is the best, & the reason is that *steel* or *carburet* of iron will retain its magnetism once given it for almost an indefinite period. If we magnetize a *steel* needle, the two ends are in different states & the needle will take a certain direction, the two ends pointing nearly north & south; that end pointing towards the north is called the *North pole* & the other is called the *South pole*. The *astatic magnetic needle* consists of two magnetic needles fixed immovably in the same pivot with their poles

in contrary directions; & it will stay in any direction you may place it, & will detect the slightest degrees of magnetism. A north & a south pole will attract, & two similar poles will repel, & therefore unlike polarities attract, & like polarities repel. There are two forms of magnet, the bar & the horse shoe magnet. A magnet must have a keeper of soft iron, protecting it when not in use, & preserving the magnetism of the magnet. Attraction will take place through all penetrable bodies known. The attraction between a magnet and unmagnetized iron depends on the polarities being brought about on the principles of induction.

XV. Currents of electricity have currents of magnetism running around such currents. Galvanic currents of electricity will make unmagnetized iron temporary magnets; & in the same manner a steel needle may be made a permanent magnet. The effect of the circular currents of magnetism, running around any current of electricity will tend to make a magnetic needle assume a cross position.

XVI. The electro magnetic telegraph is formed on the principles of forming & destroying an electro magnet, by closing &

& breaking a circle having galvanic currents & by this reproduce a motion which is availed of to produce a motion in a steel point which impresses marks upon a strip of paper which by mechanical arrangements is made to pass over a roller.

XVII. Electricity can be produced in a copper wire wound around the keeper of an electro magnet by approaching & ultimately separating by a mechanical contrivance, the keeper from the magneto-electrical.

XVIII. Attraction between ponderable particles always takes place at inestimable distances which are incapable of mensuration. Particles of ponderable matter appear as if in contact, but they are probably not so although they may form lumps or aggregates; as Cold Can contract matter almost indefinitely, which could not be the case if the particles touched each other, for then they could not get any closer. The aggregation of different kinds of ponderables constitutes so many different kinds of ponderable elements distinct in their nature, & we have two kinds of attraction between particles which may take place either between particles which are alike or between particles which are unlike. When the attraction takes place between similar particles it is called homogeneous attraction or cohesion or the attraction of

aggregation. When the attraction is between unlike particles it is called heterogeneous attraction or chemical affinity. The attraction of aggregation presents ponderable matter to our senses in lumps or masses. This is modified by the force of Caloric which gives rise to three states of aggregation of ponderable matter, Solids, liquids & gases. When the homogeneous attraction acts uniformly & with a slowly increasing force between particles which are free to move, the parts will when they get settled arrange themselves Symmetrically so as to form geometrical shapes which are called crystals, & the act which forms them is called crystallization, & the Science investigating the laws of these acts Crystallography. The forms of crystals are secondary or primary. Crystals have certain edges through which they can be split easily & regularly, & also in parallel layers. This is called the cleavage; but they do not split parallel to their natural faces. The form the crystal has given to it by nature or art is called the secondary form, & that form obtained by the cleavage is called the primary form; & all the sides produced by the splitting interlock each other. There are 15 primary forms described, the principal of which are the Square, rectangle, rhomb, & rhomboid, Cube, also prisms with 4 sides, octahedrons, dodecahedrons &c. There

are a great many kinds of powers called by different names

Caloric sometimes forms heterogeneous attraction, & Chemical affinity. The pressure of the atmosphere influences Chemical affinity. Chemical affinity is divided into 3 classes. 1st Simple Combination, 2nd Single elective affinity & 3rd Double elective affinity. Simple Combination the opposing two dissimilar ponderable particles to the sphere of each others action & the two particles unite & no other phenomena occur. In Single elective affinity 3 particles are concerned & there is not only combination but decomposition at the same time. When the 3rd particle introduced has more affinity for one substance than the other, it supplants the one first in combination & expels it. Double elective affinity has 4 articles concerned & there is a double Combination & decomposition.

XIX. A compound is a ponderable substance from which we can obtain different sorts of elements, & an element is a ponderable substance out of which we can extract only one sort of matter. There are 65 indecomposable or simple bodies. Compound bodies can be analysed. By analysis we mean the separation by purely chemical means of the constituents of a compound when we get to the elements

comprising that Compound. Such analysis is called ultimate analysis.

When we get only the different Compounds making up a more complex Compound, which are called the proximate Constituents, the process is called proximate analysis.

XX To prevent Confusion Chemists have adopted a method of Signifying the name of each Element by an appropriate letter, & the different chemical combinations by combinations of these Elements. The following table will exhibit the name Symbol & Equivalent of the different Elements

Non Metallic.	Symbol.	Equival.	Non Metallic.	Symbol.	Equival.
Oxygen	O	8	Carbon	C.	6
Hydrogen	H.	1	Boron	B.	11
Nitrogen (Azote)	N.	14	Silicon	Si	21
Sulphur	S.	16	Metallic Elements		
Selenium	Se	40	Potassium	K	39
Phosphorus	P	32	Iodine	I.	23
Chlorine	Cl	36	Lithium	L.	6
Iodine	I	126	Calcium	Ca	20
Bromine	Br	78	Magnesium	Mg	12
Fluorine	F	19	Barium	Ba	68.69

Metalli.	Symb.	Equiv.	Metalli	Symb.	Equiv.
Strontium	Str	44	Mercury	Hg	202
Aluminium	Al	14	Silver	Ag	108
Barium	Ba	7	Gold	Au	199
Zirconium	Zr	34	Platinum	Pt	99
Radium	Ra		Rhodium	Rh	52
Uranium	U	32	Palladium	Pd	53
Erbium	Er		Cesium	Cs	100
Yttrium	Yt		Iridium	Ir	99
Thorium	Th	60	Ruthenium	Ru	52
			Nickel	Ni	30
Iron	Fe	28	Cobalt	Co	30
Manganese	Mn	28	Uranium	U	60
Zinc	Zn	32	Cerium	Ce	46
Cadmium	Cd	56	Tantalum	Ta	44
Lead	Pb	104	Didymium	Di	
Tin	Sn	59	Andrium ? Rhenium		80
Copper	Cu	52	Antimony	Sb	129
Bismuth	Bi	213	Arsenic	As	75

Metallie	Symb.	Eqv.	Metallie	Symb.	Eqv.
Chromium	Cr	26	Rhodium	Rh	
Molybdenum	Mo	48	Tellurium	Te	64
Tungsten	W	92	Titanium	Ti	25
Columbium	Cu	185	Vanadium	V	68
Niobium	Nb		Uranium	U	60

XXI. The different terminations to designate Acids & Salts can be perceived by reference to the following Schedule

Carbon. Carbonic acid. Sulphur; Sulphurous acid, Sulphuric acid
Oxide, protoxide, deutoxide or binoxide, trioxide, sesquioxide
peroxide -

Hydro Sulphuric Acid or Sulpho hydric Acid

Salt containing an acid acid, forms an ite salt

Salt " " ic " " " ate "

ide or uret. Chloride of Sodium - Sulphuret of Lead.

Oxygen has an affinity for every other ponderable except fluorine
& when combined with certain elements forms an acid compound.

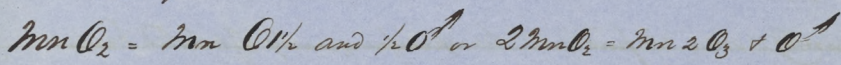
Acids containing oxygen are called Oxy-acids, & bases

containing oxygen are called Oxi bases.

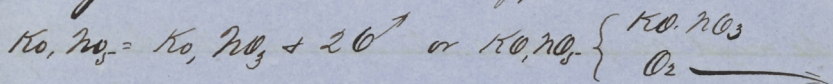
XXII. Specific gravity takes notice of the relative weights of different bodies when taken of equal bulk. Water is taken as the standard & is therefore called unity or one. To find out the specific gravity of a solid heavier than water we weigh the substance in water & the amount it loses, is equal to the weight of a quantity of water equal in bulk to the solid itself. There has been an instrument invented for this purpose called the gravimeter which will also find out the specific gravity of solids lighter than water. To find out the weight of a solid lighter than water, weight the solid in water & place upon it a weight sufficiently to overcome its buoyancy, & that will give the weight of an equal bulk of water, which of course will be greater than the weight of the solid itself. To obtain the specific gravity of liquids you fill a bottle with water & weigh it, then afterward fill the same bottle with the liquid & weigh it. You can also weigh a solid in water, & then in the given liquid & this will give the specific gravity of the liquid.

XXIII. Oxygen may be obtained in various ways. It is generally prepared in but 3 ways. 1st heating dilute oxide of manganese 2nd; from the nitrate of potassa, or Saltpetre 3rd from chloride of potassa; by heating these substances to a low red heat.

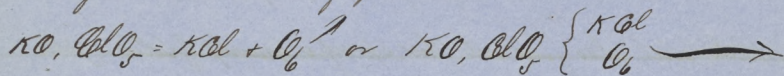
When you heat black oxide of manganese, the result is as represented in the following formula,



when you use Saltpetre, nitrate of potassa



when you use chlorate of potassa



The theoretical Specific gravity of Oxygen is 1.1054, but it is calculated as 1.111x. The atmosphere contains a proportion of

Oxygen $\frac{1}{5}$ of the atmosphere in bulk. Atmospheric air is a supporter of Combustion because it contains Oxygen. The Capacity for heat of the product of Combustion is much less than the Capacity for heat of the Combustible and the supporter.

Oxygen is eminently a supporter of Combustion. Iron will burn ~~in~~ it; also Sulphur, with a blue lambent flame. Oxygen air will ignite a snuff & make it burn brightly while phosphorus will burn in it with a light so intense as almost to dazzle the eyesight of the observer. Oxygen is a supporting animal life in respiration but it is too stimulating by itself.

Non Metallic Elements.

1. Oxygen
2. Sulphur
3. Nitrogen
4. Fluorine
5. Chlorine
6. Bromine
7. Iodine
8. Selenium
9. Phosphorus

Metallic Elements

10. Arsenic
11. Chromium
12. Vanadium
13. Molybdenum
14. Tungsten

15. Boron.

16. Carbon

21. Silicon

22. Hydrogen

17. Antimony

18. Tellurium

19. Columbium

20. Titanium.

The above are the Electric Elements in regular order from the best positive to the best electric negative.

XXIV. Oxygen exists as an element in nearly all animal and vegetable substances. Hydrogen is found in water where it is combined with oxygen. It is obtained by the decomposition of the water in which the oxygen is removed & the hydrogen remains.

It may be obtained by inserting zinc in water when the formula is $H_2O + Zn = ZnO + H_2^{\uparrow}$, this is a slow process & we can hasten it by combining with it Sulphuric acid, when we have $H_2O + Zn + SO_3 = (ZnO, SO_3) + H_2^{\uparrow}$. We can use iron instead of zinc. It may be prepared in other ways. Hydrogen was first decreed as a distinct element by Cavendish in 1766. It is the lightest element known; it is 16 times as light as oxygen & about $14\frac{1}{2}$ times as light as atmospheric air. Hydrogen is an element in almost all animal & vegetable substances. This great liberty makes it proper for inflating balloons. The specific gravity of Hydrogen by Calculation is 0.0694. This gas is very eminently a combustible, it burns with a flame, & when it burns in air, it is because the atmosphere contains oxygen with which the hydrogen unites & with which it forms water. It is not a supporter of Combustion, & with pure oxygen burns with an intense heat sufficient to melt the most infusible substances.



When Hydrogen burns it combines with a quantity of oxygen which is 8 times its own weight, but only half its own bulk. For convenience, to represent different bulks we use different geometrical figures & to represent unity in bulk we use a square \square & therefore half a volume must be designated by a parallelogram \square & we use arithmetical figures to represent differences in weight. To represent the weight of a volume, we place the arithmetical figure within the geometrical figure, thus $\begin{smallmatrix} 1 \\ \square \end{smallmatrix}$ $\begin{smallmatrix} 8 \\ \square \end{smallmatrix}$ and therefore water consists of $\begin{smallmatrix} H & O \\ 1 & 8 \end{smallmatrix} = \begin{smallmatrix} HO \\ 9 \end{smallmatrix}$ as the equivalent of water. One volume of Hydrogen combined with half a volume of oxygen will form one volume of Steam, or of water in a state of gas or vapor. To form one volume of water, there must be some Condensation, or mutual penetration, decreasing the volume of the two substances; but the weight of the body formed is found by adding together the Equivalent weights of its different Constituents. Some chymists use Hydrogen as the Standard of combining weights calling it one, but others use oxygen as the standard calling it one hundred. These two systems do not touch analysis at all, but the different ratios are called or expressed by different

Series of numbers. Where hydrogen is taken as 1 the system is called the hydrogen scale; but where oxygen is taken as 100 as the standard it is called the oxygen scale. The difference between the two can be seen by the following representation.

Hydrogen scale $\begin{matrix} H & - & O & - & N & - & Cl & - & S & - & Fe \\ 1 & - & 8 & - & 14 & - & 36 & - & 16 & - & 56 \end{matrix}$

Oxygen scale $12.5 - 100 - 175 - 450 - 200 - 56$

These two series of numbers constitute equal ratios & therefore either one can be converted into the other by the rule of proportion as in the following example,

O.	N.		O.	N.	
8	: 14	∴	100	: 175	
<u> </u>			<u> </u>		} one ratio being 12.5 as great in number as the other
H. Scale			O. Scale		
<u> </u>			<u> </u>		

Water is the protoxide of hydrogen, but hydrogen combines with oxygen in another proportion forming the deutoxide of hydrogen, or oxydised water. Steam is about 1700 times the bulk of the water from which the steam is formed, or more exactly 1698.

Water Combines with Solids in two forms, in Solutions & in hydrates. Salts Contain water in a solid state, In some it is loosely Combined, & in others it is Combined more powerfully.

When loosely Combined it is called the water of crystallization, & when Combined with more force it is called basic water. Hydrogen has been used in the analysis of compound airs known to contain oxygen, by mixing the compound air with an excess of hydrogen say twice the volume of the whole compound. Such a mixture is exploded in a tight vessel, the oxygen unites with the hydrogen & forms water. By measuring the amount of gaseous matter which has disappeared gives the amount of hydrogen contained in the air.

XXVI. Nitrogen is present in Atmospheric air, & is generally obtained by decomposing atmospheric air. The chemical agent may be phosphorus or a mixture of iron filings & Sulphur.

It is a little lighter than atmospheric air, its specific gravity being 0.9727. Nitrogen will not support Combustion. It is indifferent to respiration. The 1st Combination with Oxygen is atmospheric air 2nd Nitrous Oxide, 3rd Nitric Oxide & hypernitrous acid 5 Nitrous Acid 6 Nitric Acid. In 5 volumes of air there are 4 of nitrogen & 1 of ^{20.6} Oxygen, there is also a small proportion of carbonic acid (1 in 2000 parts) & a trace of ammonia.

There is also moisture in it dissolved in a gaseous state. This

moisture may be measured by an instrument called a hygrometer.

XXVII. Almost all animal substances contain nitrogen, & therefore nitrogen may be said to be characteristic of animal substances. Atmospheric air is a compound & not a haphazard mixture. Its composition is as shown by the following diagram.

$$\begin{array}{r}
 \text{N} \\
 \hline
 14 \quad 8 \\
 \hline
 14 \quad 8 \\
 \hline
 0.9722
 \end{array}
 \quad
 \begin{array}{r}
 \text{O} \\
 \hline
 36 \\
 \hline
 2.4999
 \end{array}
 \quad
 \begin{array}{r}
 \text{at air} \\
 \hline
 2.5 \quad .9722 \\
 .9722 \\
 .5555 \\
 \hline
 2.4999
 \end{array}
 = \frac{1}{2} \text{ of } 2\frac{1}{2} \text{ Vol. of at air; therefore } 1 - \frac{1}{2} \text{ of 1 Vol. of at air,}$$

Nitric acid is the compound of nitrogen which contains the most oxygen. To obtain this maximum compound you decompose a compound containing nitric acid. The nitrates as a class contain this substance. A convenient nitrate for this purpose is the nitrate of potassa which is called in Commerce, nitre, & salt petre. Put a certain portion in a retort & pour upon it some sulphuric acid: the sulphuric acid unites with the potassa, & separates the nitric acid, which being by itself can be distilled over. The retort is connected with a receiver. In an ordinary distillation in glass, you use one equivalent of nitrate of potassa, to two of liquid sulphuric acid. (strictly, Sulphate of water) This is also called Aqua fortis, literally Strong water. The formula with other compounds are on the opposite page.

NO, NO_2 and $2[\text{HCl}, \text{SO}_3] = [\text{NO}, \text{NO}_2] + \text{HCl}, \text{SO}_3 + \text{HCl}$ Boiling point, 184°

Nitric acid (dry) equivalent $14 + 40 = 54$ ----- $\begin{matrix} 14 + 40 \\ - \text{NO}_2 \end{matrix}$ [Orville]

Strongest liquid nitric acid [nitrate of water] $\text{NO}, \text{NO}_2 =$ Sp. gr. 1.52

Former official acid. ----- $\text{NO}, \text{NO}_2 + \frac{1}{2} \text{HCl}$ " 1.5

Present official acid (acidum nitricum) [U.S.] $\frac{1}{2} \text{NO}, \text{NO}_2$ " 1.42

Acidum nitricum dilutum U.S. $\frac{1}{3}$ i to $\frac{1}{3}$ vi of water Boiling point 250°

Nitric acid may be also procured from nitrate of Soda which is very common in South America. The reason is there is a little excess of water say $\frac{1}{2}$ equivalent is united with the Sulphate of water, when it is not of its full strength; as the full strength is 1.846 while the Commercial strength is not more than 1.843, & often not so much. The most stable compound of nitrate of water is where water acts as the base the nitrate of 4 waters, as the density is 1.42. Nitric acid is used in chemistry, in pharmacy, in medicine & the arts. It is used to form the aqua regia, lunar caustic, ointment of the nitrate of ^{Mercury} ~~Silver~~; ceterum ointment, which is an ointment of the nitrate of the oxide of mercury. It is used in the manufacture of the red precipitate. Pure nitric acid is a colorless liquid like water. The impure nitric acid is yellow. It is a

general Solvent for the metals; but it will not dissolve gold nor platinum, nor certain rarer metals. When nitric acid is added on mercury it will furnish an oxide through the mercury, a part of it will become an oxide; & the other part of the nitrogen will go off as nitrous oxide, which by combining with the oxygen will be immediately turned into red fumes; which is called in the books, nitric acid of fuming.

XXVIII. Nitrous Oxide is obtained from the solid nitrate of ammonia, which when heated in a glass retort to a temperature of 500° is converted into nitrous oxide & water, & there is no residue. Nitrous oxide consists of one equivalent of nitrogen & one of oxygen thus $\begin{matrix} n \\ 14 & 8 \end{matrix}$ & the equation is $NH_3, NO_2 = 2NO + 3H_2O$. It is elastic, colorless, of a sweetish taste, & peculiar smell; its specific gravity is 1.02. When breathed it produces a partial & transient intoxication, & on this account is called laughing or exhilarating gas. It is almost as good a supporter of combustion as pure oxygen itself. It is also called the protoxide of nitrogen. In nitric oxide the quantity of oxygen is double what it is in nitrous oxide; & it is obtained by the action of diluted nitric acid upon

copper shavings. It forms red fumes with oxygen. In its formation, part of the nitric acid is decomposed in the oxygen which exists in the metallic Copper, & it loses enough to reduce the amount of the oxygen in the Nitric acid to contain only two equivalents of oxygen. The nitric oxide is irrespirable. It supports Combustion with great vividness.

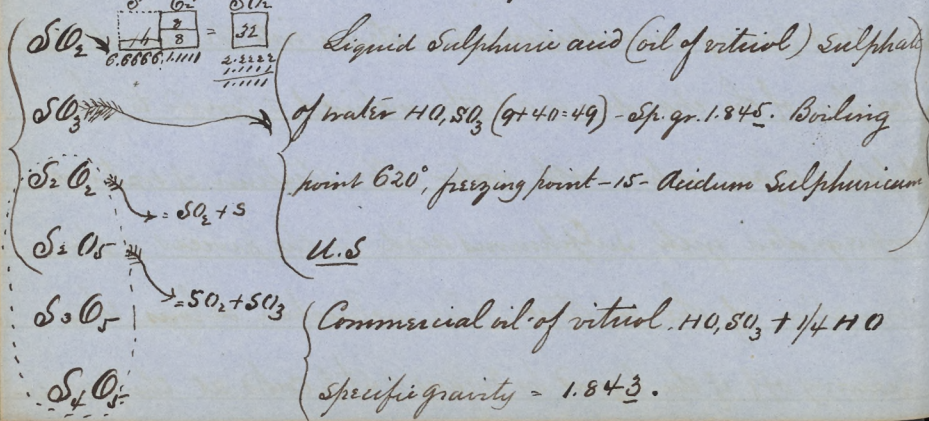
XXIX. Sulphur has a perceptible taste & a peculiar smell when rubbed or heated. Its specific gravity is 2. Next to oxygen it is the most electro-negative substance known. Its chemical properties are much like those of oxygen. It is present in almost all forms of animal & vegetable substances, but only in minute proportions. This is evident when animal products undergo a state of putrefaction. It is a crystalline substance having a shining appearance. It is brittle under the influence of heat. It is an abundant mineral found chiefly in volcanic regions. Sometimes it is found as native Sulphur, at other times in union with other substances principally metals. It may be obtained from the native Sulphur, or from its metallic Combi-

nations, principally the sulphurets of iron & of Copper. Iron lumps
 are put in an earthenware cylinder where the mineral is exposed to
 heat; & by long exposure to air & moisture, the sulphur becomes Sul-
 phuric acid, & the iron becomes protoxide of iron, & this will form
 coperses or green vitriol. The sulphur thus obtained is crude sulphur
 & contains $\frac{1}{12}$ of impurities. Sulphur may be obtained by heating
 the substance to melting (called Sublimation) when the vapor
 is sent to a receiver under 22 $^{\circ}$ into a cold chamber where
 it lignifies & passing into a vessel containing water solidifies
 into a powder. At the temperature of 180 $^{\circ}$ Sulphur emits its
 peculiar smell; at 220 $^{\circ}$ it melts. If heated in close vessels
 it boils at 600 $^{\circ}$; if heated in open vessels at 300 $^{\circ}$ it takes fire
 & burns with a blue flame & generates Sulphurous acid. Sulphur
 is used to form matches because it takes fire at a comparatively
 low temperature. It is used for bleaching purposes. In the
 manufacture of gunpowder there is a consumption of a great
 amount of Sulphur. Gunpowder contains 16 Sulphur, 16 charcoal
 & $\frac{3}{4}$ Nitre or Saltpetre. It is used in the Pharmacopoeia as
 sublimated Sulphur, washed Sulphur, & precipitated Sulphur.

Sublimated Sulphur contains a little Sulphuric acid which makes it disposed to gripe when used as a laxative. This can be washed away by means of a little warm water when it is called Sulphur lotum or washed Sulphur. To prepare precipitated Sulphur, boil Sulphur with lime which forms a Sulphuret of Calcium, if then, hydrochloric acid be added there is formed chloride of Calcium remaining in solution; part of the hydrogen, leaving the chlorine, unites with Sulphur giving rise to Sulphuretted hydrogen; another part of the hydrogen comes off by itself; and part of the Sulphur set free from the Sulphuret of Calcium will be precipitated

XXX The principal combinations & properties of Sulphur are shown in the following table

Sulphur.. S. . . eq. wt. 16. . . Eq. vol. $\frac{1}{16}$. . . Sp. gr. solid. 2. . . vapor, 6.6666



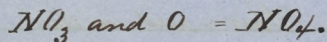
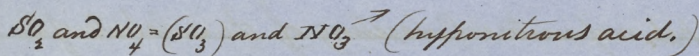
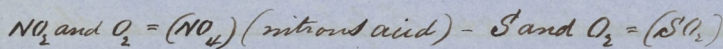
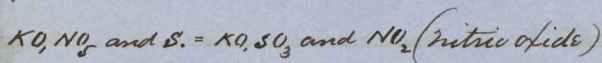
Commercial Sulphuric acid is oil of vitriol. It has a great affinity for more water. It sets fire to phosphorus. Oil of vitriol has an oily Consistence. It is generally prepared by burning Sulphur or brimstone with $\frac{1}{8}$ its own weight of nitre (Saltpetre). This furnishes to the Sulphur, through the nitric acid of the nitre more oxygen than the Sulphur would unite with had it been burned in the oxygen in the atmosphere. The combustion is effected in chambers lined with Sheet lead. They are generally oblong square Cavities; at one end of each is the furnace with its mouth outside. There is an iron tray on the furnace extending into the chamber, and on that tray the mixture is placed, & thus set fire to, & certain fumes rise in the chamber, Sulphurous acid gas & nitrous acid vapor; & there is in the chamber some moisture (many manufactures pass steam into the chambers.) The floor of the chamber is a little inclined & covered to the depth of a few inches with water. The stratum of water is impregnated with Sulphurous acid in the process of the formation of the mixture. The inclination allows the drawing off of the liquid by means of Stop Cocks at the proper

moment. During the Combustion the simple water becomes
 impregnated with Sulphuric acid & becomes a Sulphate of water
 with an excess of water. When the liquid at the bottom of the
 chamber gets so much Sulphuric acid as to weigh 1.53 then it
 may be drawn off into leaden pans or boilers & is boiled down
 until it gets to a specific gravity of 1.7. Then it is transferred to
 either glass or platinum retorts where it is distilled, & this
 brings very Sour water & makes the mixture still stronger; &
 in the retorts it is brought to the maximum strength, a Su-
 per Sulphate of water, which is 1.845. Sulphuric acid thus obtained
 contains $\frac{1}{4}$ of 1 pct. impurities Consisting of the Sulphate of the
 Oxide of lead & the Sulphate of potassa. This is acid in the
 form of Sulphates. It is an agent in obtaining Nitric & Muriatic
 acid & many other acids. Sulphurous acid is obtained by
 the action of Sulphuric acid on certain metals as mercury
 when part of the Sulphuric acid is decomposed by boiling
 liberating one equivalent of oxygen which excites the mercury
 & is reduced to Sulphurous acid which is collected over water or
 mercury, generally the latter. There is also formed a Sulphate

of the oxide of mercury. It is a noxious acid absorbable by water.

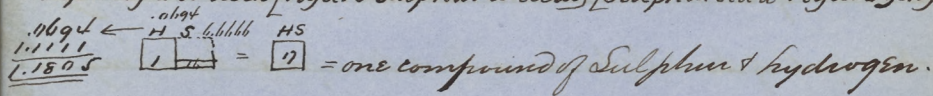
It is a non supporter of Combustion. Water takes up 33 times its own volume & the Sulphurous acid is then called aqueous Sulphurous acid. Its symbol is SO_2 . It may be Condensed into a liquid by the Cold of Zen. Liquid Sulphurous Acid has a Specific gravity of 1.45. It boils at 114° .

A formula for obtaining Sulphurous & other acids is as follows —



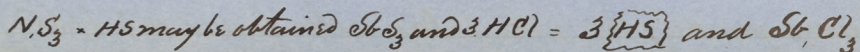
XXXI. Sulphur Combines with hydrogen in two proportions forming Sulphuretted hydrogen & Bisulphuretted hydrogen

Sulphohydric acid [hydro sulphuric acid] [sulphuretted hydrogen] =



Bisulphuretted hydrogen — — — — — $\text{H}, \text{S}_2 = 1 + 32 = 33$

Sulphur combines with nitrogen



Sulphuretted hydrogen is obtained from the action of hydrochloric acid upon the trisulphuret of antimony & it is collected over mercury in gas, & there remains in the vessel in which the decomposition takes place a ^{tri-}chloride of antimony. Sulphuretted hydrogen has a disagreeable odor. It is but sparingly absorbed by water when we get the gas hydrosulphuric acid.

This is called a *hydride*. The salts it forms are called *hydrosulphates*, or *sulpho hydrates* or *hydrosulphurets*. It is a good test for lead & for arsenic. It is the most deleterious gas known. Silver when not used will contract a superficial tarnish which is a sulphuret of silver formed by the sulphur of the sulphuretted hydrogen floating in the atmosphere & the silver. Sulphur is combined with nitrogen in the trisulphuret of nitrogen N_2S_3 but it is of no importance.

Selenium--*Se*--*Eq. wt.* 40--*Sp. gr.* 4.3. boiling point 680° was discovered in 1818 by Berzelius. It forms several compounds, viz:

Protoxide of Selenium (aqueous) SeO = $40 + 8 = 48$

Selenious acid - - - - SeO_2 = $40 + 16 = 56$

Selenic acid - - - - SeO_3 = $40 + 24 = 64$

} with
Hydrogen

Selenium + Hydrogen --- $H_2Se = 1 + 4(1) = 41$ with Hydrogen

It is a solid of a dull opaque appearance, looking something like black lead when it is in mass. Reduced to powder in a glass mortar it is a dark red powder. When first discovered it was supposed to be a metal. It is a bad conductor of heat & a bad conductor of electricity. When heated to a temperature of about 212° it gets soft, & then with a wire can be drawn out into long threads having a reddish appearance. Heated to 650° it boils, coming over in a dark colored vapor of a deeper yellow than Sulphur vapor. When treated by means of a blow pipe, it goes off in vapor & combines with the oxygen of the air forming a gaseous oxide which has a peculiar characteristic, smelling like rotten horse radish. It forms with Oxygen a protoxide of Selenium which is gaseous; a selenious acid; & selenic acid. Selenious acid is perfectly analogous to Sulphurous acid. Selenic acid is perfectly analogous to dry sulphuric acid. The selenites are analogous in properties & form to the Sulphites, & the selenates to the Sulphates &c. Selenium & Sulphur are said to be isomorphous elements & form similar shaped crystals. It forms with

hydrogen a compound called seleniumttered hydrogen analogous to sulphuretted hydrogen, but a more systematic name is selenio hydric acid, although it is called hydro-selenio-acid

XXXII. The next element is Phosphorus.

Phosphorus. *P.* eq. wt. 32. eq. vol. $\frac{1}{2}$. Sp. gr. (solid) 1.77 (vapor) 4.444
melting point 108° , boiling point 550° , discovered by Brandt in 1669.
It is obtained most readily from bone which by burning leaves the phosphorus, while the organic part is converted into its elements. The substance left after the combustion is lime and phosphoric acid. This is Calvered bone, or phosphate of lime, or bone ash, or more correctly bone phosphate of lime. Dilute oil of vitriol will decompose the phosphate of lime, unite with the lime, forming sulphate of lime or gypsum which is nearly insoluble. In this way most of the lime is taken from the phosphoric acid & the solution obtained is called the acid phosphate of lime. The sulphate of lime appears as a white muddy looking substance among the materials. The materials are strained through a bag, the acid phosphate of lime passes through & the sulphate remains in the bag as a white pulp.

Evaporate the phosphate of lime until it gets the consistence of a syrup; you then mix it with 1/4 its weight of charcoal powder, & this is dried at a low red heat, & then the dry mass is exposed in an earthen retort, to a gradually increasing heat until full redness is obtained, & it is kept so for many hours; this decomposes the phosphoric acid of the acid phosphate of lime, the charcoal combines with the oxygen of the phosphoric acid & the phosphorus will be set free; the heat of the retort must be kept under water. There are several gases given off in the reaction. When perfectly pure, phosphorus is colorless; but it generally has a flesh color appearance. It has a garlicky smell, always gives off slight fumes when exposed to the atmosphere indicative of a slow combustion; in a dark room it is luminous; it is a little stiffer than wax, it is sectile & very combustible. The point of combustion is a little above 108° . If it be exposed to a temperature between $419^{\circ} + 482^{\circ}$ it undergoes a change by which its great inflammability is gone & you get what is called red phosphorus. The ordinary phosphorus must be kept under water but the red phosphorus need not be so kept. Red phosphorus

is an allotropic condition of ordinary phosphorus. It forms 4 compounds with oxygen; oxide of phosphorus P_2O_3 , $64 + 8 = 72$

hypophosphorous acid $PO = 32 + 8 = 40$; phosphorous acid

PO_3 -- $32 + 24 = 56$, Phosphoric acid (dry) PO_5 $32 + 40 = 72$.

After burning phosphorus there remains a red spot which is the oxide of phosphorus, (the oxide of bi-phosphorus). By burning phosphorus you get phosphuric acid. Phosphoric acid unites with water in 3 different equivalents

{ Phosphate of trimeter (common phosphoric acid) $3H_2O, PO_5$
 { phosphate of bimeter (pyrophosphoric acid) $2H_2O, PO_5$
 { phosphate of monometer (metaphosphoric acid) H_2O, PO_5

If you expose phosphate of trimeter to a temperature 415° till you drive off one equivalent of water & you obtain phosphate of bimeter. Phosphate of trimeter will give a yellow precipitate with nitrate of Silver. Phosphate of bimeter will give a white precipitate with nitrate of Silver. Phosphate of monometer may be formed out of Common phosphoric acid or the pyrophosphoric acid, by exposing either to a red heat when all the oxygen except one equivalent will be given off.

The metaphosphoric acid remaining is a very fusible Compound
 & when allowed to congeal forms a transparent solid substance
 resembling ice. Phosphorus forms 3 Compounds with hydrogen.

Solid phosphuretted hydrogen P_2H_4

liquid " " P_2H_2

gaseous " " PH_3 Sp. gr. 1.21

Phosphuretted Calcium in water takes fire.

XXXIII The next element is Chlorine

Chlorine -- Cl. eq. wt 36. Eq. vol. 1 Sp. gr. 2.5 -- Discovered by Scheele in 1774.

Hypochlorous acid --- ClO --- $36 + 8 = 44$ --- $4Cl + HgO_2 = 2(ClO)$ and $HgCl_2$

Chlorous acid ----- ClO_2 --- $36 + 24 = 60$

Hypochloric acid --- ClO_4 --- $36 + 32 = 68$ $\left\{ 3(ClO_2) \text{ and } 4SO_3 = \right.$

Chloric acid --- ClO_3 --- $36 + 40 = 76$ $\left. \left(2(ClO_4) \text{ and } 2(ClO_2, 2SO_3) + H_2O, ClO_2 \right) \right\}$

Hypochloric acid --- ClO_7 --- $36 + 56 = 92 = 10(ClO_2 + SO_3) = (ClO_2) + 10SO_3$

$2ClO_4 = ClO_3 + ClO_5$

Cl	ClO	ClO ₂	ClO ₃	ClO ₄
<div style="border: 1px solid black; padding: 5px; display: inline-block;">36 0 8</div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">44</div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">60</div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">76</div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">68</div>

The above table represents the different Combinations of
 Chlorine with Oxygen.

Chlorine is found in Salt where it is united with Sodium. If we act upon this by the dioxide of manganese, & add dilute Sulphuric acid, we detach chlorine from the Common Salt, & as it is gaseous the moment it is evolved, it may be collected over water, though water absorbs it to a certain extent, but warm water absorbs less than cold. It may be obtained from Hydrochloric or muriatic acid. This is decomposed by dioxide of manganese, using two equivalents of hydrochloric acid. One equivalent of chlorine flies off as a gas, the other unites with the metal manganese forming the protochloride of manganese. The two equivalents of hydrogen combine with the remaining two equivalents of oxygen & form two equivalents of water. Chlorine has a yellowish green color, & produces, when breathed in great quantity, bronchitis. By cold & pressure it may be condensed into a liquid even when dry. It is remarkable for its bleaching properties & its power of supporting combustion. It forms & compounds with Oxygen as seen in the table in the foregoing page. Water will

about 200 times its own volume of hypochlorous acid, & forms with it aqueous hypochlorous acid, which is of a red color. Its other combinations are not very important.

XXXIV. Chlorohydric acid (muriatic or hydrochloric acid) H, Cl

[Sp. gr. 1.28] Na, Cl and H, SO_3 - (H, Cl) and Na, SO_3

Aqueous muriatic acid (acidum muriaticum. U. S.)

Aqueous acid - - - Sp. gr. [strongest 1.21] [official 1.16]

Acidum nitromuriaticum U. S. (2 meas. mur. a - 1 meas. Na)

Acidum muriaticum dilutum U. S. (acid $\frac{1}{2}$ w H, Cl $\frac{1}{2}$ w Na)

Chlorine forms with Hydrogen a compound called hydrochloric acid, or chlorohydric acid, or commonly muriatic acid.

To obtain this we use the common salt (chloride of Sodium) upon which we pour Sulphate of water. Thus obtained chlorohydric acid gas, is a colorless fluid, it is transparent, has a pungent odor & when diluted in water an acid taste, & even an acid & corrosive property. The moment it is let free & distilled into the atmosphere, it forms a white fume. It is largely absorbed by water & is a sour gas. It is a non-supporter of Combustion. It can be condensed into a liquid

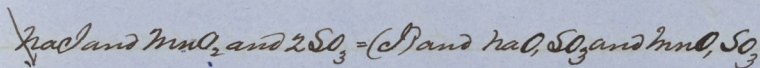
by a pressure of 40 atmospheres, & is called liquid muriatic acid. Water will take up 480 times its own bulk of muriatic acid at the temperature of ^{44°} 15° & the liquid resulting has the specific gravity of 1.21. The most usual impurities in the acid are nitric acid, & Sulphuric acid, & certain metallic impregnations generally iron. Two measures of muriatic acid with one measure of nitric acid forms an officinal acid; the acidum nitromuriaticum or aqua regia. -

Trichloride of nitrogen $\text{NCl}_3 \dots \text{NCl}_3, \text{HCl}$ and $3\text{ClO} = \text{NCl}_3$ and $\text{HCl} + 3\text{H}_2\text{O}$.

Chlorine Combines with nitrogen forming a trichloride of nitrogen which is the most explosive substance known with Sulphur, chlorine forms ClS_2 a bisulphuret of chlorine. With Selenium ClSe_2 a bisulphuret of chlorine. With Phosphorus it forms PCl_3 a trichloride of phosphorus, and PCl_5 a pentachloride of phosphorus

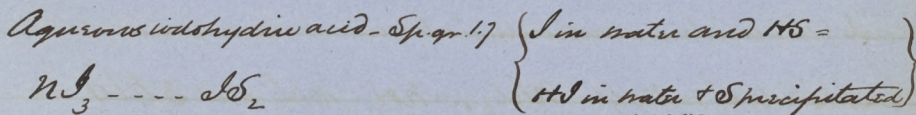
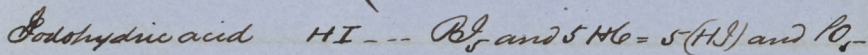
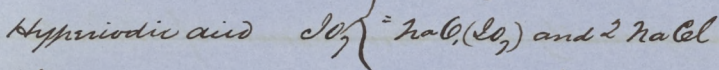
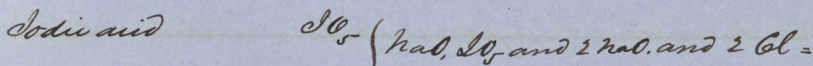
XXXV. Iodine is an important element & is used a great deal in medicine. Its formula & some of its combinations are given in the formulae on the opposite page

Iodine. I. *Eq. vol.* 126. *Eq. vol. (vap.)* 1. *Sp. gr. (solid 4.9) (vap. 8.7)* Lavoisier 1812



Sodium U.S.

Hypiodous acid $\text{IO}?$



Iodine was discovered by Lavoisier, a Soda Manufacturer of Paris in 1812. It has a violet colored vapor whence its name. The ashes of Kelp contain Iodide of Sodium, some Saline impurities & charcoal. To obtain iodine; powder Kelp & act upon it with water which takes up the Soluble parts of the carbonate of Soda & Iodide of Sodium, which latter being most Soluble, the solution is evaporated to a pellicle; allowing this to cool, the carbonate of Soda crystallizes by itself, & the Iodide of Sodium remains in the liquor which is strained off. Act on this Kelp liquor with a little Sulphuric acid, & the vapors of iodine are set free. In practice the decom-

roving influence is assisted by the dioxide of manganese. The equation is $\text{KacI} + \text{MnO}_2 + 2\text{SO}_3 = \text{I} + \text{K}_2\text{O}, \text{SO}_3 \text{ and } \text{MnO}, \text{SO}_3$, Thus we get Iodine, Sulphate of Soda, & Sulphate of protoxide of manganese.

Iodine is a bluish black solid with a metallic luster. It is crystalline, can be crumbled between the fingers, leaving an orange stain which evaporates. Impure iodine does not possess these properties. It has a burning acid taste & a peculiar smell, similar to that of chlorine but not so strong. It is sparingly soluble in water, taking 7000 times its weight of water to dissolve it thoroughly. It forms a beautiful violet vapor, which is sometimes a supporter of combustion. Iodine is of great use in all pharmaceuticals. It forms 3 combinations with oxygen as seen in the table. Iodic acid is obtained by taking Nitric acid & throw into this Iodine & boil it. The Nitric acid gives off oxygen enough to form with Iodine, Iodic acid. This is a crystalline solid of no importance. Hyperiodic acid is obtained from Iodic Soda & caustic Soda & chlorine, as seen in the table, when we get Chloride of Sodium & hyperiodate of Soda. This is of no particular use. IO_2 and IO_3 are analogous to Chlorine & hypochlorous acid. Iodine forms with Hydrogen Iodohydric acid which is a gas. Its synonym is

hydriodic acid but this is not systematic. It is obtained as seen in the formula from the quintessence of phosphorus & water; when we obtain iodohydric acid & phosphoric acid, the former passing off as a gas, which being largely absorbed by water & decomposed by Mercury; is collected by displacement, as it is heavier than atmospheric air. Its specific gravity is 4.42. The gas is prone to unite with the air. It is decomposed by chlorine, which has a greater affinity for hydrogen than has iodine. When water is saturated with this gas at ordinary temperatures aqueous iodohydric acid is formed, its sp. gr. is 1.7. The solution is made by diffusing iodine through water which is acted on by a stream of Sulphuretted hydrogen, when the Sulphur is precipitated as seen in the table. Iodohydric acid is analogous to chlorohydric acid gas. Aqueous iodohydric acid has been proposed to produce the full alterative effect of Iodine & it is a very reasonable theory. Iodine combines with Nitrogen in the triiodide of Nitrogen. This is a very explosive compound, made by digesting iodine in a solution of Ammonia. The matter is separated & dried in small particles. Iodine forms with Sulphur a Bisulphuret of iodine, called in the pharmacopoeias iodide of Sulphur, or

Sulphurus iodidum & it is used only externally in the form of ointment called *unguentum Sulphuris iodidi*. Phosphorus unites with iodine, the most interesting compound being PI_3 the triiodide of phosphorus. Iodine is distinguished by its reaction with Cold Starch forming a blue color. When combined it cannot be found in this manner

XXXVI Iodine (*Iodinium*, U.S.) is official

I Purified *Iodinium Purum* - Sublim

II Astringent. *Tinctura Iodini*

Unguentum Iodini

III Combined with S. *Sulphuris Iodidum*

Unguentum Sulphuris Iodidi

IV Combined with Metals. *Potassii Iodidum*

Ferri Iodidum

Plumbi Iodidum

Hydrargyri Iodidum

Hydrargyri Iodidum Rubrum

Arsenici Iodidum

Liquor arsenici et Hydrargyri Iodidi

V. Assd with KI. *Liquor Iodini Compositus*

Tinctura Iodini Composita

Unguentum Iodini Compositum

The above are all the officinal preparations of Iodine

Iodine is freely Soluble in water in a Solution of Iodide of Potassium.

Bromine. Br. Eq. wt. 78. Eq. Vol. (vapor) 1. Sp. gr. (liquid) 3

Brominium U.S. -- Potassii Bromidum U.S. (vapor 5.4)

Bromine is so called from its fetid odor. It was discovered in the residuary liquor of Salt works, called bittern. It has also been found in the waters of the Mediterranean in minute quantities. In bittern it is combined with Magnesium as Bromide of Magnesium. A stream of Chlorine is passed through this, when Bromine is set free & Chloride of Magnesium is formed. Ether is used to evolve the Bromine & there is an ethereal solution which is saturated with potash, forming Bromide of Potassium which is decomposed by the Peroxide of Manganese & Sulphuric acid. It forms a beautifully colored vapor, something like the color of nitrous acid vapor. It is officinal in the U.S. Pharmacopoeia but not in the British. It forms a quintessence of Bromine, Bromic acid & also Bromohydric Acid.

Fluorine is formed from the mineral Fluorspar or Fluorshinn-
spar which is composed of Fluorine & Calcium & the mineralised
fluoride of Calcium & it crystallises in octahedrons. When manipu-
lated with acids, the matter set free corrodes glass vessels & also all
metals not excepting platinum. It was at length obtained by using vessels
made of fluor spar itself, from decomposing a fluoride of mercury by a
stream of fluorine. It is a yellowish brown gaseous substance, about
which little is known. Its symbol is F equal volume 19. This
is an acid gas like chlorohydric, iodohydric, & bromohydric acid

XXXVII

Carbon is a very important element.

Carbon -- C . Eq. vol. 6 -- Eq. vol. 1... Sp. gr. (as diamond 3.5) (as charcoal 0.44)

Carbonic oxide -- CO - $6+8=14$ -- Carbonic acid CO_2 - $6+16=22$

Acids - Oxalic C_2O_3 - Mellitic C_6O_3 -- croconic C_3O_4

C_2O_3 and SO_3 CaO , CO_2 and $SO_3 = (CaCO_3)$ and CaO, SO_3

CO_2 and CO Aqua Acidi carbonici us

Carbon occurs in many vegetable & animal substances. It is found in
the mineral kingdom in plumbago, in anthracite, & in bituminous
Coal. In plumbago & in Coal it is nearly pure. It occurs combined
in the Carbonates many of which are native, as the carbonate of lime &c.

Carbon exists in the air as Carbonic acid but in small quantity there being 1 part in 2000. It occurs perfectly pure & crystallized as the diamond. It is found in animal charcoal. When wood is burned in a limited quantity of air, the main parts of charcoal will remain containing the acids. When bituminous Coal is treated similarly, the product is called Coke. Tar or resin or rosin burned with a smoky flame will produce vapors which may be caught against porous shreaths & accumulate forming lamp black, which is charcoal minutely divided. In making gas for illumination, the iron retorts on the inside, get coated with a dense Carbon called gas Carbon. Animal substances thrown in the fire & scorched through & through, will be turned into a charcoal called animal charcoal. The substance usually charred for this purpose is bone. A like substance may be obtained from ivory, & it is then called ivory black, while that obtained from bone is called bone black. Ivory black is the more dense of the two. The diamond was originally found exclusively in Asia, but is now procured also from Brazil. They are generally found in regions which produce gold. Its specific gravity is 3.5. Diamond when burned yields only Carbonic acid gas, and when Charcoal is burned it produces

only Carbonic acid gas. This may be decomposed by potassium & in both cases an identical black powder is produced. The diamond is sometimes a little colored, owing to a very minute impregnation of mineral matters. Charcoal is insusceptible of decay & it will prevent putrefaction in other substances, & even in some cases restore things which have become putrid. It is a good conductor of heat & electricity. It will destroy the color, taste, & smell, of various substances, & therefore it is called a powerful decolorizer, & deodorizer. Carbo ligni and Carbo Animalis are officinal in the US pharmacopoeia. Carbo animalis must not contain phosphate of lime. When bone black is acted upon thoroughly by muriatic acid to dissolve bodily the phosphate of lime, & is then washed with distilled water it is called Carbo animalis purificatus.

Animal Charcoal is superior to wood charcoal as a decolorizer.

Carbon unites with Oxygen in five proportions, forming one oxide & four acids as seen in the table. Carbonic Acid is obtained from Carbonate of lime in any form. Take chalk & add Sulphuric acid, Sulphate of lime is obtained while Carbonic acid is expelled. It may be formed by burning charcoal in Hydrogen. It is a colorless gas, having a pungent odor, & acidulous taste. It is present in malt liquors & in

offensiveness mines. It is irrespirable, & will not support Combustion. In small quantities in the Air, it acts as a narcotic poison. Its specific gravity is 1.52. It has been condensed into a liquid by Faraday in 1823. In 1836 it was solidified by Dehniar a lamp maker of Paris by suddenly letting out the liquid Carbonic acid, & cold enough was produced to freeze it. Dr. Mitchell solidified Carbonic acid by a machine of his own contrivance. He used

Bicarbonate of Soda and Sulphuric acid, to obtain the Carbonic acid. He employed a strong iron vessel closed by a strong screw. Water takes up its own volume of Carbonic acid gas. Solid Carbonic acid has a temperature of 80° below Zero. It will freeze Mercury.

Carbonic oxide may be obtained, collected passing through caustic Potash which absorbs Carbonic acid. It burns with a blue luminous flame. It is more deleterious than Carbonic acid.

XXXVIII Carbon unites in various proportions with Hydrogen

Carbohydrogens. $\text{CH}_4 - \text{C}_2\text{H}_6 - \text{C}_4\text{H}_{10} - \text{C}_6\text{H}_8$ gas C_8H_8 certain vol. oils C_8H_8

Light Carbonated hydrogen $\text{CH}_4 - \text{C}_2\text{H}_6\text{O}_2, \text{HO} - \text{C}_2\text{H}_5$ and 2CO_2

Elephant gas C_2H_2

Carbon + Sulphur. Bisulphuret of Carbon CS_2

Carbon forms with Chlorine 1. CCl_4 , 2. C_2Cl_6 , 3. C_2Cl_4

Carbon with Nitrogen forms three Compounds

(1.) Bicarburet of Nitrogen (Cyanogen) N_2C_2 or Cy

(2.) Paracyanogen $n. C_2$

(3.) Mellen $n. C_6$

Carbon forms various compounds with Hydrogen as seen in the table.

The light Carbonated Hydrogen is often called Marsh gas, for in summer when the Sun is very hot, & the bottom of a pond is stirred up, bubbles of Air will rise to the Surface, which when examined proves to be light Carbonated Hydrogen. It can also be obtained from certain Acetates as vinegar. If you mix 4 parts of Crystallized Acetate of Soda, 4 parts of Caustic potash, and 6 part of quick lime: the mixture will yield this gas & Carbonic Acid, which latter is absorbed by the Caustic potash. The lime prevents the Caustic potash from acting on the glass vessel.

A strong heat must be applied. It is inflammable & produces water & Carbonic Acid. It is the fire damp in Coal mines which sometimes

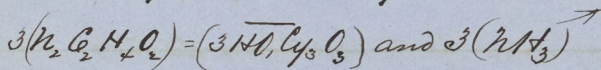
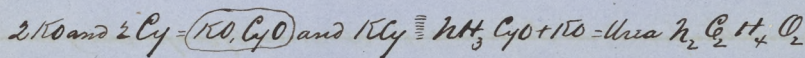
~~explodes~~ the whole atmosphere of the mine, when it rises to equal the ratio of the atmospheric air. To prevent these Catastrophes, Sir Humphrey Davy invented a lamp which could give light to the miners without giving rise to any explosion. For this purpose he

constructed a lamp enclosed in a cage of wire gauze, which is called the Davy - Another Compound of Carbon & Hydrogen is Olefiant gas so called because it will make an only Compound with Chlorine. Acting on Alcohol with 5 or 6 times its weight of Sulphuric Acid, the SO_2 takes up water from the Alcohol & Olefiant gas is given off & collected over water. This is the most valuable ingredient in the gas for illumination. When set fire to, the products are water & carbonic Acid. Oil makes a valuable gas for illumination. Carbon unites with Nitrogen in 3 proportions, as Cyanogen, Paracyanogen, & Mellon. Cyanogen has a separate Symbol Cy. Paracyanogen is an isomeric compound. Cyanogen is obtained from the Bismut of metallic mercury. When this is heated, the Cyanogen is driven off, & mercury is left with some paracyanogen in the form of a brown powder, while Cyanogen itself is gaseous & is collected over mercury, as water absorbs $4\frac{1}{2}$ times its own volume. Alcohol absorbs 25 times its volume. It was discovered by Guillusae. It is used in Prussian Blue. Its specific gravity is 1.815. It burns with a blue flame tinged with purple. Mellon is of no importance. With Sulphur Carbon forms Bisulphuret of Carbon, which is made by heating charcoal

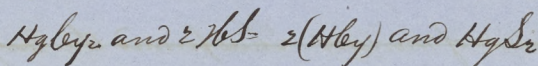
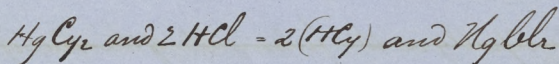
in a porcelain tube to a red heat, & passing over it a vapor of Sulphur. It is very volatile, & has a detestible, fetid smell. Carbon unites with Chlorine in 3 proportions as seen in the table. Cyanogen & Mellon are compound radicals & unite with other substances in the same manner as elements.

XXXIX Cyanogen unites with various elements

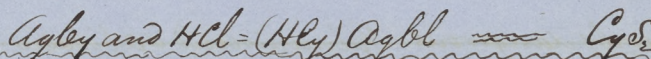
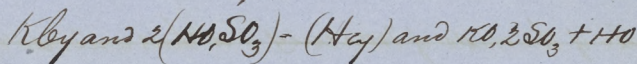
Cy with O - Cyanic acid CyO - Fulminic acid Cy_2O Cyanuric acid Cy_3O_3



Cy with H - Hydrocyanic or Prussic acid HCy or $H(Cy_2)$



Acidum Hydrocyanicum (Dilutum) U. S.



Cyanogen is the bivalent of nitrogen but it acts like a simple element & has therefore a separate symbol Cy . It forms various combinations with Oxygen, Hydrogen, Sulphur, Chlorine and iodine. The oxides of Cyanogen are Cyanic acid

Fulminic acid, & Cyanic Acid, which are polymeric Compounds.

CyO, the monobasic Compound Cyanic Acid is obtained by passing a stream of Cyanogen gas through some caustic alkali. Being perhaps we get Cyanate of Potassa, and Cyanide of Potassium as seen in the table. The Cyanic acid cannot be obtained alone without being decomposed. It is a thin colorless liquid having the smell of acetic Acid. The monohydrated Cyanate of ammonia is identical with Urea, the characteristic organic matter found in the urine, & is obtained by evaporating urine to a Syrup. The Analogy is seen in the equation in the table.

Fulminic acid has not as yet been obtained separately, but combined with bases principally as the fulminate of the oxide of Silver, & the fulminate of the oxide of mercury. Thus formed the Compound is a very explosive substance. The percussion Cap is filled with the fulminate of the oxide of mercury & is thus rendered explosive. It is excessively dangerous. Fulminic acid is a dibasic. It forms four acid fulminates. Cyanic acid is obtained by expressing urea to a heat a little beyond its fusing point when it is turned into a greyish powder which is composed of 3eq. of Cyanate of water & 3eq. of Ammonia. The Ammonia is driven off as a gas and

Cyanuric acid is ~~left~~ combined with water which is acting as
 a base & therefore Cyanuric acid is tribasic. It cannot be
 obtained any purer than combined with water. It is solid,
 sparingly soluble in water & may be crystallized from its
 solution, when it takes up extra 4 eqs of H_2O (water of crystallization).
 Cyanogen forms only one acid with hydrogen. That is the
hydrocyanic acid or as it is more commonly called Prussic
 acid. This interesting acid is presented dry as anhydrous, or
 hydrated when combined with water for medicinal use. Dry
 prussic acid is obtained from the Bicyanuret of Mercury
 acted upon by a compound containing hydrogen as
 hydrochloric acid, when we obtain hydrocyanic acid & the
 Bichloride of Mercury (corrosive sublimate) as seen in the
 table. The hydrocyanic acid is driven off by heat; Chloride of
 Calcium is placed in a tube to take up the water & the dry
 acid is sent into a tube surrounded by ice. The bicyanuret
 of Mercury may be acted upon by Sulphuretted hydrogen
 when hydrocyanic acid is obtained & bisulphuret of
 mercury (Cinabar.) & dry hydrocyanic acid is liquified

under a temperature of 80° & has Sp. gr. 69. At about 80° it is a gas or vapor & its Specific gravity is then .94. The perfectly dry acid is the most powerful poison known. It becomes solid at the temperature of 5° . There is no antidote which can be depended upon for the poison of hydrocyanic acid.

When used medicinally the acid is hydrated. Its most systematic name is Cyanohydric acid. The medicinal acid is official in the US pharmacopæia. It is made by the action of dilute Sulphuric Acid upon the ferrocyanuret of potassium. Its appellation is Acidum Hydrocyanicum Dilutum. The yellow salt used in this reaction is a compound of Cyanuret of potassium & cyanuret of iron, but the latter has nothing to do with the compound. After the process, there is found in the retort Bisulphate of Potash, as seen in the equation in the table. The fixed dilution adopted is a dilution containing 2% dry acid & 98% of water. It may be tested as to its proper strength by lunar Caustic. The dry acid is said to have a burning followed by a cooling taste. The medicinal acid has the odor of peach

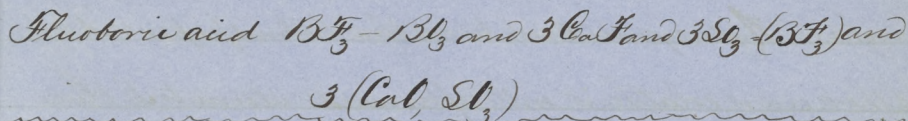
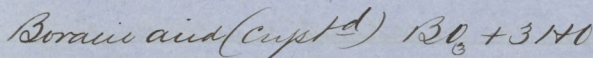
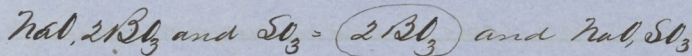
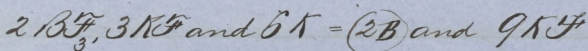
Clopones. When the strong acid is kept too long it becomes brown
 & is spoiled. A little hydrocyanic acid may be obtained from
 the cyanuret of silver, by pouring on this some hydrochloric
 acid. By a double decomposition a chloride of silver is obtained
 which precipitates, & there is also formed hydrocyanic acid. To
 get this of proper strength the constituents must be carefully
 weighed. Hydrocyanic acid turns blue litmus paper red, but
 as the acid is volatile it will afterwards return to its blue
 color, but if impregnated with Sulphuric, muriatic or
 other acids, the paper will be permanently reddened.

Cyanogen combines with Sulphur forming a compound
 radical the Bisulphuret of Cyanogen called Sulphocyanogen
 it will form an acid with hydrogen. With chlorine
 cyanogen forms 2 polymeric Compounds, chlorides of
 cyanogen. Iodine & Bromine also combine with
 Cyanogen. Mellon forms with hydrogen an acid
hydro-mellonic acid. With metals it forms mellonides
 or mellonurets of the metals.

XL.

Boron

Boron B. Eqwt 11. Eq vol (vap) 1?



Boron exists naturally with Oxygen in native Boracic acid which is found sometimes alone, or Combined with Soda as native borate of Soda or Borax. It was formerly incorrectly called Boracium as it was considered metallic. Potassium will decompose Boracic acid when Boron will be evolved. The process is seen in the equation above $+ \text{B}_2 \text{O}_3 \text{ and } 3 \text{ K} = \underline{\text{B}} \text{ and } 3 (\text{K}, \text{BO}_3)$ when we form boron & Borate of potassa. After the reaction wash the production water & dissolve the Borate of Potassa. Boron may also be obtained from the double fluoride of potassium & boron, which is acted upon by potassium & times its weight.

when the Substances formed are Boron & fluoride of potassium. Boron is an olive brown powder, takes fire at 600° Fahr, & the product is Boracic Acid. A piece of boron thus burned, is glazed & the interior is protected from further combustion & the Combustion is therefore extinguished. Boron is very little known & it is an object of philosophical Curiosity. With Oxygen, Boron forms but one Compound Boracic acid, which is a tetroxide of boron. Boracic acid is obtained either from the native boracic acid purified or from decomposing the Borax. In Tuscany there are warm lakes which are weak solutions of Boracic acid. It issues in steam from cracks, is collected & then purified. To obtain it from borax, treat the tetroborate of Soda (which is obtained from ponds in Persia, India & China, which dry up & form a crust on their surface, which is crude borax, becoming white & crystallized when purified) with Sulphuric acid, & there obtain a Sulphate of Soda (Glauber's Salt) & the boracic acid is set free. It will precipitate in shining scales. The Equation is $2NaCl, 2KB_3 + SO_3 = (2KB_3)$ and $2NaCl, SO_3$. Boracic

acid is a white solid substance in crystalline scales which are greasy to the touch & not unlike the clippings of Spermaceti. In this state it is hydrated & its equivalent is $B_2O_3 + 3H_2O$. Sp. gr. about 1.47. It melts when exposed to heat $1st$ by the agency of the water in its composition & this melting is called the aqueous fusion. This water by continued heat may be driven away & continuing the heat, it melts again & this melting is called the igneous fusion. Then being allowed to cool it forms a transparent substance, looking like glass, & called vitrified Boracic acid. When kept long, it loses its transparency. As an anhydrous acid it has Sp. gr. 1.8. It was discovered in 1702 by Brandberg who, calling it a salt used it in medicine & ascribed to it sedative powers. A test for boracic acid is dissolving it in Alcohol & when this solution is set on fire, Alcohol burns with a greenish flame. With Fluorine Boron forms the compound Fluoboric acid BF_3 which is a gas. It may be obtained by acting with Sulphuric acid on fluorspar & vitrified boracic acid when the product is fluoboric acid & Sulphate of Lime. The gas

being absorbed by water in proportion of 700 to 1 it is collected over mercury. Its sp. gr. is 2.36 by Calculation 2.37 by experiment.

Silicon Si Eq. wt. 21. Eq vol (vap) 1? Silicic acid (Silica) SiO_2
 $2 \text{SiO}_2, 3 \text{H}^+ \text{ and } \text{OH}^- (2 \text{Si}) \text{ and } 9 \text{H}^+$

Fluosilicic acid $\text{SiF}_3 - \text{SiO}_2$ and $3 \text{CaF}^+ \text{ and } 3 \text{SiO}_2 (\text{SiF}_3)$ and
 $3 (\text{Cal. SiO}_2) \approx 3 \text{SiF}_3 \text{ and } 3 \text{H}^+ = (3 \text{H}^+, 3 \text{SiF}_3) + \text{SiO}_2$

Silicon in fact Cannot be volatilized. Silica may be decomposed by potassium, when the products are Silicon and fluoride of potassium. The double fluoride of potassium + Silicon may be decomposed by potassium Silicon is a brown powder, dull in appearance, without lustre. It was obtained in 1824 by Berzelius, though hinted at in 1802 by Sir Humphry Davy. It is insoluble in Sulphuric, Nitric, or Nitro Muriatic Acid. By heat it undergoes Combustion producing Silica or pure flint. The Silicon is burned only on the surface when the Silicic acid protects it although its interior has attained a red heat, when it is altered in its properties being no longer Combustible nor Soluble either in a Concentrated Solution of Caustic potash or

hydrofluoric acid as it was before ignition. There are 2 allotropic states of Silicon. When a piece of Silicon is burned the nucleus will present the Second State of Silicon & may be taken out by acting upon the outer glass by hydrofluoric acid. With hydrogen it forms Silicic Acid, Silica (flint) SiO_2 , in a quartz agatized wood, rock crystal & many other minerals. It may be obtained from rock crystals by heating it red hot & throwing it into water, forming powdered Silicic acid which is a harsh white substance of Sp. gr. of 2.6, formerly called Silix. It combines with bases forming many minerals called Silicates. With fluorine it forms the fluosilicic acid which is a terfluoride of Silicon made similarly to fluoroboric Acid. It is an acid gas, decomposed by water into a new acid which dissolves into the water and then Silicic acid appears like soft snow.

XLI The metallic elements are generally designated by the termination um & they may be seen in the table on pages 65 and 66 Commencing with Potassium down to Iridium.

Potassium. K. Eq. 39. Sp. gr. between 8 + 9 melts at 150° . It was discovered by Sir Humphrey Davy in 1807

KO , CO_2 and CaO , H_2O = $(KO \text{ in } H_2O)$ and CaO , CO_2

KOH and $2Fe$ = (K) and H and $2FeO$

$KO + C$ = (K) and CO

K with O Potoxide of potassium (dry potash) KO 47

Peroxide " " K_2O_2 63

K_2O_2 and $2K$ = $3KO$, K_2O_2 = KO and $2O$

K with S - KS - KS_2 - (KS_3) - KS_4 , KS_5

Potassic Sulphurium as $3KS_3$ and KO , SO_3

$4KO$ and $10S$ = $(3KS_3 \text{ and } KO, SO_3)$

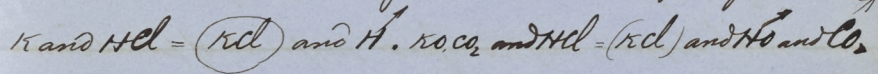
The metals can be arranged in electro positive & electro negative groups. The former may be converted into salts & the latter group into acids. These latter have been called acidifiable metals. Basifiable metals are those which combined with Oxygen form the bases of salts. The basifiable metals are arranged in 3 subdivisions 1st Those soluble in water & possessing an acid burning taste, which are called alkalis. 2nd They may form a base sparingly

Soluble in water & difficult of reduction to the metallic
 state as. Earths 3rd A base easily reduced to the metallic
 state & generally insoluble in water, called an ordinary
 oxide. The acidifiable metals are not susceptible of any
 convenient subdivisions. There are 3 alkalies, Potassium,
 Sodium & Lithium forming bases called potassa, Soda, &
 lithia. The almost Exclusive Source of potassa from
 which we get potassium is the ashes of plants provided they
 grow some distance from the sea. If wood ashes are acted
 upon, they are soluble in water & the solution obtained
 is potassa united with Carbonic acid as carbonate of
 potassa. If this is concentrated by boiling down & mixed
 with hydrate of lime there will be a double decomposition
 forming hydrate of potassa & carbonate of lime is precipi-
 tated. Straining this you get hydrate of potassa which is
 evaporated until a solid substance is obtained which
 is potassa united with water, a solid hydrate of potassa.
 Acting upon this with Iron at a white heat, a decompo-
 sition again takes place, & potassium is obtained as well

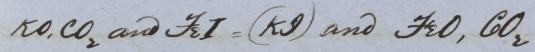
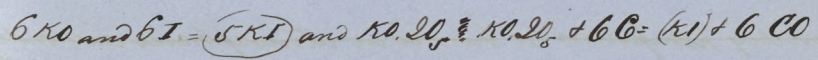
as hydrogen which goes off, & peroxide of iron, the metal,
 being left by itself. This metal is lighter than water. Sir
 Humphrey Davy obtained it by subjecting a strong solution
 of hydrate of potassa suspended over mercury to electrolysis,
 by a powerful galvanic battery. Potassa may be decomposed
 by charcoal at a white heat when potassium is obtained
 separately & carbonic acid goes off as a gas. Potassium has a
 metallic lustre which when recently cut is like that of
 silver, but it becomes immediately tarnished. It may be
 moulded in the fingers. It has a strong attraction for
 oxygen. When thrown on water it is made to take fire first
 fusing when water is decomposed; hydrogen is given off &
 set fire to by the heat generated & combined with some of the
 vapor of potassa & burns with a purple flame. Potassium
 forms with oxygen, dry potassa, or protoxide of potassium
 which is very hard to get. It has no practical importance.
 When dry potassium is burned in atmospheric air or dry
 oxygen gas it takes 3 equivalents of oxygen & forms K_2O_3
 usually called peroxide of potassium. It cannot be

combined with acids. Thrown on water it forms potasa which dissolves, & oxygen which is given off by effervescence as gas. Dry potasa may be obtained from trioxide of potassium. Take dry trioxide of potassium and add 2 equivalents of potas- sium & let them react. The product is 3 equivalents of dry potasa. Hydrate of potasa is Caustic potasa. With Sulphur potassium forms 5 Sulphurets as seen in the table. The trisulphuret is the only important one. It is present in the Potassii Sulphuriticum of the ~~U.S.~~ pharmacopoeia & it is made by fusing Sulphur with twice its weight of dry carbonate of potasa. The Carbonic acid is expelled in the reaction & there is a reaction between potasa & Sulphur & we obtain Sulphurets of potassium and Sulphate of Potasa.

XIII. K with Cl Chloride of Potassium (dry muriate of potasa) KCl 75



Potassii Iodidum us KI $39 + 126 = 165$



There are several official preparations given on next page

Liquor Iodini Compositus U.S.

Tinctura Iodini Composita U.S.

Liquor Potassii Iodidi Compositus London

Unguentum Potassii Iodidi. U.S.

Unguentum Iodini Compositum U.S.

Potassii Bromidum U.S. KBr $39 + 78 = 117$

KCl , CO_2 and $FeBr$ = (KBr) and $FeCl_2$

If potassium be introduced in an atmosphere of Chlorine it takes fire spontaneously & forms Chloride of Potassium

If potassium be heated in an atmosphere of chlorohydric acid, hydrogen will be evolved & the compound formed will be carbonate of Potassa saturated with chlorohydric acid

This evaporated to dryness will produce chloride of potassium. It is a white anhydrous salt tasting bitter though something like Common Salt. It is soluble in water but not in alcohol. It crystallizes in the form of Cubes & contains no water of crystallization. It was formerly called dry muriate of potassa because bleaching gas was formerly considered to be a mixture of

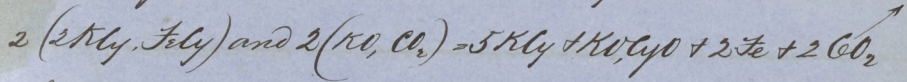
dry muriatic acid & Oxygen. Potassium Combines with Iodine. It takes fire in vapor of iodine forming iodide of potassium which is officinal in the U.S. Pharmacopoeia in several forms as seen in the table. It is formed from potash & iodine which forms Iodate of potash & iodide of potassium. Combining with Iodate of potash some Carbon or charcoal, you form carbonic oxide & iodide of potassium, the decomposition taking place at a dull red heat. Iodide of potassium may be obtained from the iodide of iron which is added to a solution of carbonate of potash when we form protoxide of iron which combines with Carbonic oxide as carbonate of the protoxide of iron; iodide of potassium is precipitated & is evaporated until it crystallizes in cubes. It is an anhydrous salt soluble in water & to a less extent soluble in alcohol. It is not deliquescent in a moist atmosphere. It may contain impurities. When the impure salt is added to lime water it renders it a little opaque & milky from the carbonic acid uniting with lime as chalk which is insoluble in

water. A solution of pure Salt will not discolor the tincture of iodine, but the impure Salt will. The impure Salt may be distinguished by the appearance of the crystals. The pure Salt is totally Soluble in alcohol & the other is not.

There is no true *Liquor Iodini* as iodine is insoluble in water but iodine is Soluble in a solution of iodide of potassium thus obtained it is called *Liquor Iodini Compositus*. Recent tincture of iodine is precipitated by water. To get a tincture which will not precipitate iodide of potassium is added to the tincture forming *Tinctura Iodini Composita*. There are 3 official ointments 1. Iodine with lard, 2 Iodide of potassium + 3rd Iodine & Iodide of potassium mixed with lard. The *unguentum potassii iodidi* is made from Iodide of potassium $\mathfrak{z}\text{i}$ with Lard $\mathfrak{z}\text{i}$ and *Unguentum iodini Compositum* Iodide of potassium $\text{gr} \times \times \times$ Iodine $\text{gr} \times \vee$ Lard $\mathfrak{z}\text{i}$ + alcohol $\mathfrak{f}\mathfrak{z}\text{ss}$. the latter being used to work it up properly. Potassium unites with Bromine forming Bromide of potassium official in *U.S. Pharmacopoeia* formed from Bromide of Iron & the

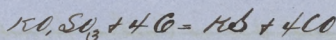
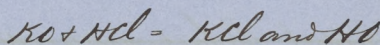
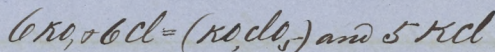
Carbonate of potassa as seen in the table. It is an anhydrous salt & gives off beautiful vapors when acted on by Sulphuric acid. It is not much used in medicine but it has properties analagous to iodide of potassium although it is not so active. The dose is from griss to grss 3 times a day

Potassii Cyanuretum us Rly - 65



This is a poisonous salt formed from Ferrocyanuret of potassium (formerly called prussiate of potassa) with dry Carbonate of potassa. Thrown into a deep iron Crucible & exposed to a white heat until the substance converts on a glass rod; it is then poured out like white enamel & is the Cyanuret of potassium. There is an impure Cyanuret of potassium of a variable strength. It is an opaque white amorphous substance with a sharp alkaline bitter almost taste, soluble in water & alcohol. In water it forms hydrocyanic acid, & the oxygen turns the potassium into potassa. The average dose for an adult is $\frac{1}{4}$ grain largely diluted in water.

XLVII

3 Carbonates of KO - KO, CO_2 - $\text{KO}, 2\text{CO}_2$ - $2\text{KO}, 3\text{CO}_2$ KO, CO_2 (a) Potassa Carbonas Impureus, US (pearlash)(b) Potassa Carbonas US (Salt of tartar)(c) Potassa Carbonas purus US $\text{KO}, 2\text{CO}_2$ Potassa Bicarbonas USHydrate of potassa KO, HO { Potassa US, Potassa hydratis London
Liquor potassa USPotassa Nitras US KO, NO_3 Potassa Sulphas US KO, SO_3 (vitriolated tartar)Potassa Sulphas cum Sulphure EdinPotassa Bisulphas Lond + Ed $\text{KO}, 2\text{SO}_3$ Potassa Chloras Lond KO, ClO_2 -

Potassium must be kept under Naphtha. Potassium forms salts with acids. With oxygen it forms potassa, the protoxide of potassium. Potassa may be combined with several acids. Potassa as a base forms salts with

Carbonic acid. It forms 3 carbonates, a monocarbonate, a bicarbonate, & a Sesqui Carbonate of potash. The monocarbonate of potash has 3 grades of purity which are official.

When wood ashes are dissolved by water & evaporated to dryness a solid matter is procured which is a very impure Monocarbonate of Potash. This is generally made in a large Caldron or pot, & hence the name potash. This is the potash of Commerce & it contains much Carbonaceous acid. When this is subjected to heat in a retortatory furnace, the Carbonaceous matter is burned out & it is called pearl ash. The very impure Salt is not official, although pearl ash is as *Potash Carbonas Impureus*. It appears like broken Sugar & has a soapy alkaline taste.

All acids will expel the carbonic acid from a Carbonate. When pearl ash is acted upon by Cold water, the pure monocarbonate of potash is dissolved out. This is put in a clean iron pot, evaporated over the fire till it thickens & it is then to be taken off & stirred until it granulates.

This is official as *Potash Carbonas* & was formerly called Salt of Tartar, because it may be also obtained from Cream

of tartar. A 3rd Variety is officinal as Potassa Carbonas purus, which is the pure Monocarbonate of Potasa.

Another Carbonate is the Bicarbonate of Potasa & it contains twice as much carbon as the former variety. Make a solution of the Monocarbonate & pass through it a stream of Carbonic acid until it is saturated, & then crystals will be formed which are Bicarbonate of Potasa. The Monocarbonate is Effervescently Soluble in water & gets moist in the air & if exposed for some time it dissolves. The bicarbonate is not deliquescent. It has a saline but not disagreeable taste. It is officinal as potassa bicarbonas & the dose is from gr. x to gr. xx. The Monocarbonate when dissolved in water forms an officinal solution $\frac{3j}{\text{of the Substance in f\ij}}$ of water. Sal Aeratus is made by Submitting Monocarbonate to the action of an atmosphere of carbonic acid when it absorbs a fresh amount of Carbonic acid not enough to make it a fair bicarbonate of potasa & it is therefore a Supercarbonate of potasa. Potassa Carbonas purus is made in the pharmacopoeia from Potassa Bicarbonas

which when exposed to heat loses 1 Eq of Carbonic Acid & a
 very pure Monocarbonate will be left. When Cream of tartar
 & Saltpetre are burned together, we obtain as a result of the
 deflagration a monocarbonate of potassa which is free
 from silica. Salt of Tartar now expresses a very pure Mono-
 Carbonate of potassa in matter how obtained. Potassa the
 base will combine with water as an acid forming an offic-
 inal Compound Hydrate of Potassa KO, HO . This is called
 Potassa in the US pharmacopoeia. It is made by double
 decomposition between Monocarbonate of potassa &
 hydrate of lime when there is formed hydrate of potassa in
 solution & carbonate of lime which is insoluble. When this
 reaction is over the solution is evaporated to dryness & the
 dry solid matter is fused & cast into sticks. This is not a
 very pure hydrate of potassa & it is called Potassa by Lime. Its
 great impurity is carbonate of potassa which has not been
 decomposed. This is rendered pure by alcohol which will
 dissolve the hydrate of potassa, but will not dissolve the
 carbonate. This solution is evaporated of its alcohol.

& the substance is obtained pure & called potassa by alcohol.
 It is deliquescent. There is an officinal solution of this
 called *Liquor potassæ*. With Nitric acid, potassa forms
Potassæ Nitras or Salt petre which may be formed naturally
 or chemically. Nitre is found in India. It is first obtained
 as crude nitre but is purified by repeated dissolutions and
 crystallizations. This has a sharp, saline taste. It is soluble
 in 9 parts of Cold & its own weight of warm water. It is
 fusible at 600° & may be cast into moulds & it is called
 (~~Sal fusibile~~ ^{*munella*}). This is used in the arts to manufacture
 Sulphuric acid & gunpowder & it is often used in the
Pharmacopœia. Salt petre is poisonous & there is no anti-
 dote known, but Stimulants are necessary to save the
 life of the patient. Nitre is obtained artificially from
 Calcareous matters in combination with decomposing
 animal or vegetable substances & these preparations are
 called nitre beds. Sulphate of potassa is officinal
 & may be formed from Sulphuric acid being poured
 upon Cream of tartar, & it is called vitriolated Tartar.

It forms white hard crystals. It is anhydrous & is used in
 Ross's powder Every 10 grs of which Contains 8 grs of Sulphate
 of potassa, 1 gr opium & 1 gr ipecacuanha. When deflagrated
 with an equal weight of Sulphur, a Sulphate of potassa is
 formed with an excess of Sulphur. It makes a yellow
 solution & is said to have alterative Effects. There are other
 Sulphates of potassa, as seen in the table official in the
 Pharmacopoeias, as Bisulphate of Potassa. This has been
 employed in effervescing draughts. Chlorate of potassa
 is used in the London Pharmacopoeia. It is made by
 passing a stream of chlorine through Caustic potassa.
 It is a white salt & produces Combustion very readily.

XLIV. Sodium Na. Eq 23. Sp gr 0.97 Melting p 200°. Sir H Davy 1808

Protide of Sodium (dry Soda) NaO 23 + 8 31

Protide of Sodium NaO_2 23 + 16 47

Protosulphur of Sodium $\text{NaS} \equiv \text{NaO}, \text{SO}_2 + 4\text{C} = \text{NaS}$ and 4CO

Sodii chloridum us (Common salt) $\text{NaCl} = \text{NaCl} + \text{HOSO}_2 = \text{HCl} + \text{NaO}, \text{SO}_2$

Soda Sulphas us $\text{NaO}, \text{SO}_2 + 10\text{H}_2\text{O}$

Sodium is a basifiable metal forming a fixed alkali Soda by combining with Oxygen. It is analogous to potassium in many of its properties. It was discovered by Sir Humphrey Davy who decomposed Soda by electrolysis. It can be decomposed chemically by white hot iron which becomes protoxidized by the oxygen of the Soda which goes over at a white heat, & the metal Sodium is obtained. Of late Sodium has been obtained by a new process. Acetate of Soda is to be ignited. The acetic acid is then turned into carbonic acid, & charcoal, & Carbonate of Soda is formed mixed with charcoal. Mix this with plenty Coarse charcoal & expose it to a white heat, & the charcoal is turned into Carbonic acid & Sodium is formed. The alkali Soda 50 or 60 years ago was called mineral alkali, & perhaps Vegetable alkali. Soda & potassa are both found in ~~various~~ vegetables & minerals. Sodium is a curious metal. Its Symbol Na is formed from the German name Natrium given to it by Berzelius. It is a malleable metal having very much the consistency of wax. It must be kept under naphtha

which contains no Oxygen. It does not take fire on Cold water but fuses & runs about. It takes fire in hot water & it often explodes. It Colors turmeric to a greenish brown.

Sodium forms 2 Oxides, dry Soda a protoxide of Sodium, & a teroxide of Sodium. Protoxide of Sodium NaO when pure & in thin slices, becomes dry Soda when exposed in dry air or in dry oxygen gas. It is an object of Curiosity.

The teroxide of Sodium Na_2O_3 may be obtained from burning pure Sodium in an excess of oxygen gas. It is an olive brown powder. It may be used to get dry protoxide of Sodium by

mixing it with 2 eq. Sodium. The protosulphuret of Sodium is obtained by decomposing dry Sulphate of Soda by charcoal at

a high temperature as seen in the Equation in the table & the Substances formed are Carbonic oxide which goes off as a gas & the Sulphur & Soda unite to form protosulphuret of Sodium.

This Substance is the coloring principle of the lapis lazuli from which ultra marine blue is obtained which is of a very unchangeable nature. The artificial Sulphuret of Sodium is found to produce a color equal to the ultra marine. Sodium combines

with Chlorine forming an officinal Compound Existing so abundantly in nature is to render its artificial manufacture unnecessary. This is Common Salt obtained by Evaporation from the water of the ocean. It is often found in masses as a mineral when it is called rock salt & is not pure. It is translucent & admits heat. Chloride of Sodium is a white anhydrous substance in coarse crystals or in powder. It is a great antiseptic & is extensively used in the arts & in pharmacy to obtain muriatic acid, & in obtaining the chlorides of Mercury, Calomel & Corrosive sublimate. It is found in the secretions. Muriatic acid is formed from the action of Sulphate of Soda water upon this substance. The salt decomposes it & two compounds are formed Hydrochloric acid which goes off as a gas & may be collected over water & the residue is Sulphate of Soda. Sodium combines with other elements but the combinations are unimportant. Soda is a strong basifiable base forming salts with acids. Its combinations are Salts of Soda. Sulphate of Soda (Glauber's Salt) is officinal, it contains 102% water of crystallization. When nearly crystallized it is in

Striated 6 sided prisms. Insoluble in 2 1/2 times its weight of Cold water & much more Soluble in warm water. Informing Muriatic Acid the residue may be treated with carbonate of Lime.

Dry. Muriatic acid	28	0	8	Sodium	23
Oxy muriatic acid			36	Sodium	23
Chlorine			36	Sodium	23

XLV. Na with CO_2 - NaOH , CO_2 NaOH , 2CO_2 2NaOH , 3CO_2

NaOH and CaH , CO_2 = $(\text{NaOH}$, $\text{CO}_2)$ and CaH

{ Soda Carbonas US NaOH , 2CO_2 + H_2O $31 + 22 + 90 = 143$
 { Soda Carbonas Elusivatus US

Soda Bicarbonas US NaOH , 3CO_2 + H_2O

Hydrate of Soda NaOH , H_2O Liquor Soda London

Nitrate of Soda NaOH , HNO_3

NaOH and HCl = NaCl and H_2O

Soda forms 3 Carbonates of which Monocarbonate & Bicarbonate are officinal. The Sesquicarbonate occurs native & is unimportant

Soda is obtained from the ashes of certain plants growing near the Sea & the ash is called Barilla it contains Soda

in a carbonaceous state, of which it contains from 25% to 40% & the balance is Sulphuret & Chloride of Sodium with various impurities, Sulphate of Soda & Carbonaceous impurities.

There is a Semifused Ash obtained from Seamed Called Kelp which contains more Soda than Barilla & contains iodide of Sodium as one of its Constituents. Carbonated Soda being Soluble, act upon the mass with Cold water which takes it up. This solution is evaporated to dryness & a pretty pure Monocarbonate of Soda is obtained. Soda is obtained artificially from Sulphate of Soda. Having a quantity of this Glauber's Salts, Carbonic acid must be substituted for the Sulphuric acid & it is therefor dried & mixed with an equal weight of Carbonate of Lime & half its weight of ground Charcoal. At a high heat, the dry Sulphate is decomposed & the result is Sulphuret of Sodium, obtained by the action of the charcoal. The Carbonate of Lime reacts upon this as seen in the table & forms Carbonate of Soda & Sulphuret of Calcium. An excess of Carbonate of Lime is generally used & the Sulphuret of Calcium is usually combined

with some lime & it is called the Oxysulphuret of Calcium
 After this reaction a black mass is obtained consisting of
 these two substances & called in Commerce black ash & it
 contains 22% Carbonate of Soda & oxysulphuret of Calcium &
 some carbonaceous impurities. The Soda is not strictly a
 monocarbonate as the great heat prevents the Soda from
 obtaining enough Carbonic acid. The black ash is acted on
 by water to dissolve the carbonate of Soda & the solution is
 evaporated & we get white ash. This Soda ash is mixed with
 4 its weight of Sawdust & heated in a furnace to give it a full
 dose of Carbonic acid. This product is dissolved in water &
 evaporated to dryness. It is again dissolved in warm water &
 evaporated to a pellicle. It is then put aside to Crystallize & it
 gets 10 eqs water of Crystallization. Soda ash contains about
 50% carbonate of Soda. This salt is more commonly obtained
 artificially although bayella & kelp are employed in manu-
 facturing Soda. It is soluble in its own weight of water. When
 heated it dissolves in its own water of Crystallization & on
 being further heated it forms an officinal dry powder.

Monocarbonate of Soda is officinal as Soda Carbonas. It is a deffloriscent Salt. On drying away the water of crystallization by effusion, a crumbling substance is obtained which is readily pulverizable & is officinal as Soda Carbonas Exsiccatus.

Bicarbonate of Soda is made by placing Crystals of Monocarbonate on shelves in an air tight box & allowing to pass in a stream of ~~carbonic~~ Carbonic acid which will be absorbed by the crystals.

The shelves are perforated by holes. During the saturation the salt contains less water of crystallization until 9/10 water drip away & trickle down from the crystals through the holes in the shelves. The crystal will retain its original shape but become opaque & very porous & drier than originally. This is generally powdered & is officinal as Soda Bicarbonas. Soda combines with water forming Soda hydras not officinal in the US pharmacopoeia. It is hydrate of Soda & is made from carbonate of Soda by the action of ~~carbonate~~ ^{hydrate} of lime. The solution formed is evaporated. In this process part of the carbonate of Soda is undecomposed & this is got rid of by using alcohol which dissolves the hydrate of Soda & the solution is then evaporated. These substances are called

Soda by lime & Soda by alcohol. The substance is similar to hydrate of Soda, behaving similarly as chemical agents. It is not deliquescent & has a sp gr of 1.3. Bicarbonate of Soda is employed for making Soda & Seidlitz's powders. Soda powders consist of Bicarbonate of Soda & Tartaric Acid. Seidlitz's powders consist of bicarbonate of Soda, Tartaric acid, & some Rochelle Salt. Nitrate of Soda is not official. It is an anhydrous salt. It occurs in South America naturally in an impure state especially in some districts of Peru. It can be rendered pure. It crystallizes in rhombs. It was formerly called incorrectly Cubic Nitre. When manufacturers of Nitric acid wish to obtain the acid economically they pour Sulphuric acid upon Nitrate of Soda & obtain Nitric acid and Sulphate of Soda. When hydrochloric acid is brought in contact with Soda it forms Chloride of Sodium (Common Salt) & water mutually decomposing each other

Phosphates of Soda formed from phosphate of Terrwater ($3140, P_2O_5$)

- (a) Acid phosphate of Soda $2140, NaO, P_2O_5$ 24H2O
- (b) Sodæ phosphas US (neutral phosphate of Soda) $140, 3NaO, P_2O_5$
- (c) Subphosphate of Soda $3NaO, P_2O_5$

There is only one official phosphate of Soda Sodae phosphas
 formed from decomposing bone phosphate of lime by
 Sulphate of ~~Water~~ with a slight excess of Carbonate of Soda.
 It crystallizes in oblique rhombic prisms which are efflorescent.
 The salt is bitter & purgative & the solution alkaline to test paper.
 Its taste is similar to that of Common Salt, & it may be dis-
 solved in Soup or quail & taken in that way

Sodae Boras U.S. (borax) $\text{NaO}, 2\text{B}_2\text{O}_3 + 10\text{H}_2\text{O}$ or $5\text{H}_2\text{O}$

This is the official Borate of Soda (Borax) of which there are
 two solutions. Impure borax is obtained from evaporation
 of certain salts. It may be obtained by saturating natural
 boracic acid with Carbonate of Soda. There are two kinds of
 borax distinguished by their crystals which are in one case
 prisms & in the other octahedrons. It is used in the arts.

Hypochlorite of Soda NaO, ClO is made by mixing chlorinated
 lime & Carbonate of Soda; & by a double decomposition, there
 is formed Carbonate of Lime & Hypochlorite of Soda in solution.

This is official as Liquor Sodae chlorinata

Superdiluates of potassa & Soda = Glaf.

Soda & potassa are distinguished by two tests. Tartaric acid precipitates Cream of tartar in potassa & forms no precipitate in Soda. Another test is by the trichloride of platinum which produces a precipitate in potassa Salt, & not in Soda Salts. A fixed alkali melted with a surplus of flint forms Glass.

Lithium L. eq. 6. Sp. gr. 0.59. Melting point 356°
This is the lightest solid known & like Potassium & Sodium it forms a fixed alkali called Lithia.

XLVI. Unknown compound NH Amidegen NH_2

Ammonia NH_3 Ammonium NH_4

NH_3, HCl and $\text{CaO} = \{\text{NH}_3\}$ and CaCl and HO

$\text{NH}_3, \text{HCl} = \text{NH}_4, \text{Cl} - \text{NH}_4, \text{Cl}$ and $\text{HgK} = \text{HgNH}_4$ and KCl

Liquor Ammoniac Fortior Us Sp. gr. 0.882

Liquor Ammoniac Us Sp. gr. 0.960

Linimentum Ammoniac Compositum Ed

St. Sol. of ammonia $\frac{1}{2}$ dr. Linct. of Camphor $\frac{1}{2}$ dr. Sp. of rosemary $\frac{1}{2}$ dr.

Spiritus Ammoniac Us

Spiritus Ammoniac Aromaticus Us - NH_3, HCl and HO, Cl_2

Linimentum Ammoniac Us = $\text{NH}_3, \text{HO}, \text{CO}_2$ and HCl

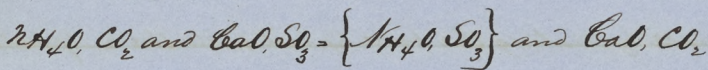
The principal Source of Ammonia is furnished by animal matter, by destructive distillation. It is a Compound of Nitrogen & Hydrogen. Animal matter is a ternary Compound Consisting of Nitrogen, Carbon, Hydrogen, & Oxygen. Animal matter has hydrogen enough in it to turn all the oxygen into water, & all the Nitrogen into Ammonia. The animal matter usually selected is refuse bone which contains, beside bone-phosphate of lime, some Cartilaginous matter, subject to the destructive distillation, which is performed in iron cylinders communicating with large receivers generally Casks. The bone is exposed to a red heat & turned into Ammonia & water which bring gases. Condense in the Casks, the water absorbing the Ammonia, Carbonic acid also Comes over. There remains in the iron Cylinders bone black, & in the Cask a brown liquor or aqueous Solution of Carbonate of Ammonia contaminated with Empyreumatic oil. This liquor is called bone spirit, from which all the different Salts of Ammonia may be formed. Another Source of the Ammoniacal Compound is furnished by the Condensable products obtained in the destructive distillation of bituminous Coal in the manufacture of gas for illumination. There are

also incondensable products which form the gas, while the volatile product is placed in a chamber to cool & its condensable portion produces a peculiar kind of tar in great quantity & a liquor impregnated with Ammonia. This dark liquid is very tarry & smells more like tar than Ammonia. The gas liquor is principally an aqueous solution of carbonate of Ammonia & it contains Sulphate, hydrosulphate, & hydrocyanate of Ammonia. Muricate of Ammonia (Sal Ammoniac) may be decomposed by being mixed in powder with twice its weight of lime. When heated produces a gaseous compound Ammonia which being very soluble in water is collected over mercury which does not absorb it. The reaction is seen in the equation in the table NH_3 , HCl and $\text{Cal} - \left\{ \text{NH}_3 \right\}$ and Cal and H_2O . There is also formed, as seen, Chloride of Calcium & water. Ammonia is a volatile alkali, gaseous, & largely absorbed by water. Its sp. gr. is 0.59. It has a pungent odor, the pure gas irritating the nostrils violently; but when diluted with atmospheric air it is rendered pleasantly stimulating. It extinguishes flame. Ammonia is absorbed by water which

takes up 430 times its own bulk. The water when saturated
 increases in weight $\frac{1}{3}$ & in bulk $\frac{1}{3}$. Decomposing Ammono-
 nia by fulgine Nitrogen can be obtained. Ammonia is
 composed of two gases 1 vol Nitrogen + 3 vols. hydrogen, &
 the 4 vols. are condensed into 2 volumes. When gaseous
 Ammonia is decomposed by Electricity it doubles in bulk
 $\frac{1}{4}$ of which is Nitrogen & $\frac{3}{4}$ is hydrogen. The elementary com-
 pound of Nitrogen & hydrogen is an unknown compound.
 It is present in hydrocyanic acid. The 2nd compound is
 Amidogen, the 3^d Ammonia & the 4th Ammonium,
 which latter can be illustrated by taking an example of an
 hydraacid Combined with Ammonia. Hydrochlorate of
 Ammonia NH_3, HCl is supposed by some chemists to become
 $\text{NH}_4 \text{Cl}$ Chloride of Ammonium. It is officinal in certain
 forms in the Pharmacopaeias, Combined with water in two
 forms, Liquor Ammoniac Fortior & Liquor Ammoniac
 Ammonium has not been exhibited in a separate
 state but in combination with mercury. Shake an
 amalgam of potassium in a solution of chloride of

ammonium, & the ammonium combined with the mercury
 forming an amalgam of ammonium, & the other compounds
 chloride of potassium. *Liquor Ammonia* is made by passing
 Ammonia extricated from a certain amount of muriate of
 Ammonia into a given amount of water. *Liquor Am-*
monia Fortior is made in the same manner on a large
 scale & when mixed with double its volume of distilled water
 it becomes *Liquor Ammonia*. *Sinimentum Ammoniae*
Compositum is made of *Sol. Col. Ammonia* $\frac{3}{4}$ lb as seen in
 the table & it is an imitation of Granville's Counterirritant
 lotion. Alcohol dissolves ammoniacal gas & forms Spirits
 of Ammonia, officinal in the US pharmacopoeia. It since
 is superseded by the Aromatic Spirits of Ammonium. The
 aromatics are Cinamon, cloves, & orange peel. Muriate of
 Ammonia $\frac{3}{4}$ lb & Carbonate of potassa $\frac{3}{4}$ lb are put in
 dilute alcohol $6x$ and distilled over $7\frac{1}{2}$ pints. The $2\frac{1}{2}$ pints
 left in the retort consist principally of chloride of
 potassa. *Sinimentum Ammoniae* is formed of 3 parts olive oil &
 1 of liquor ammonia, which by long keeping become somewhat solid

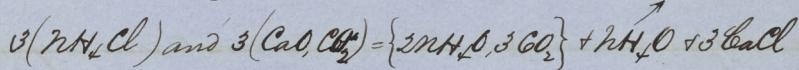
XLVII Sulphate of oxide of ammonium $2\text{NH}_4\text{O}, \text{SO}_3$



Three Carbonates of oxide of ammonium

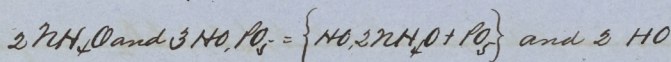
(a). Monocarbonate $2\text{NH}_4\text{O}, \text{CO}_2$

(b). Sesquicarbonate (Ammonia Carbonas US) $2\text{NH}_4\text{O}, 3\text{CO}_2$

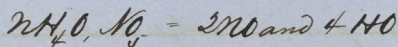


(c) Bicarbonate $2\text{NH}_4\text{O}, 2\text{CO}_2$

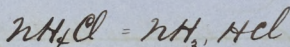
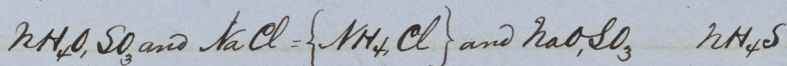
Neutral phosphate of oxide of ammonium $\text{HO}, 2\text{NH}_4\text{O} + \text{PO}_5$



Nitrate of oxide of Ammonium $2\text{NH}_4\text{O} + \text{NO}_5$



(chloride of Ammonium (muriate of Ammonia)) NH_4Cl



When dry Ammonia is mixed with a dry acid the compound formed is not the Ammoniacal Salt of the acid. Ammonia itself is not really a salifiable base, but the salifiable base is oxide of ammonium. Sulphate of the oxide of ammonium is made by saturating the Carbonate of the

oxide of ammonium present in bone spirits, by oil of vitriol. It may also be made by treating the bone spirit with the Sulphate of Lime & by reaction carbonate of Lime will precipitate & the Sulphate of the oxide of ammonium will be formed. This is soluble in water. It is not officinal. There are 3 Carbonates of the oxide of ammonium. The monocarbonate is unimportant. The Sesquicarbonate is officinal in the U.S. Pharmacopoeia as Ammonia Carbonas, although it is not actually a Carbonate of Ammonia. Its Symbol is $2\text{NH}_4\text{O} \cdot 3\text{CO}_2$. It is formed by a double decomposition between chloride of Ammonium & carbonate of Lime, & the compounds obtained are the Sesquicarbonate of the oxide of Ammonium, Oxide of Ammonium which is sublimed, and chloride of calcium. Thus obtained, it is a white, opaque, fibrous salt, with an alkaline taste & pungent smell, Soluble in cold water, & decomposed by boiling water. It is called mild volatile alkali. When exposed to the air for some time, it loses by evaporation Monocarbonate of the oxide of ammonium, leaving bicarbonate of the oxide of ammonium. Bicarbonate of oxide of Ammonium is

official in the Dublin Pharmacopoeia but not in that of the U.S. There is a neutral phosphate of the oxide of ammonium which is the neutral tribasic phosphate of the oxide of ammonium. This is formed in conjunction with water by the addition of the Sesquicarbonate of the oxide of ammonium to the phosphate of triswater. There is another phosphate called acid phosphate of oxide of ammonium, & there is also a subphosphate of the oxide of ammonium.

Nitrate of oxide of Ammonium is made by saturating Sesquicarbonate of oxide of Ammonium with Nitric Acid. It is generally crystallized but may be fused in opaque masses like white sugar. A hydracid unites with Ammonia & the hydrogen is yielded up composing Ammonium & the other element combines with the Ammonium forming another Compound. With Chlorine it forms Chloride of Ammonium (Sal Ammoniac) which is made from chloride of Sodium and Sulphate of the oxide of ammonium. It may be sublimed. It is a fibrous salt official as Ammoniac Chloras.

XLVIII. Calcium - Ca 20 - white metal Sp. gr. 1.55 - Sir H. Davy 1808

Protoxide of Calcium (Calc US Lime) CaO 20+8 = 28..... CaO_2

Liquor Calcis. US Lime water - Limimentum Calcis US

CaS = CaO , SO_3 and 4C = { CaS } and 4CO - CaP

Calcii Chloridum US CaCl + 6H₂O - Liquor calcii chloridi US

CaBr --- Fluoride of Calcium CaF

$\text{CaO} \cdot \text{H}_2\text{O}$ - $\text{CaO} \cdot \text{NO}_2$ - Carbonate of Lime CaO , CO_2

Four varieties of Carbonate of lime officinal

(a) Creta US Creta preparata US

(b) Marmor US

(c) Treta US Treta preparata US

(d) Calcis carbonas precipitatus US

CaCl and NaO , CO_2 = { CaO , CO_2 } and NaCl

CaO , SO_3 - Bone phosphate of lime 3 CaO , PO_3

Calcis phosphas precipitatus Lat, forme US Sum London

Calc Chlorinata US CaO , ClO

2 CaO + 2 Cl = { CaO , ClO } and CaCl

Ca , O , Cl - CaO , Cl Ca CaO , ClO + CaCl

Potassa cum Calce US

Calcium forms an earth, lime, in equal combination with Oxygen. It is an abundant Substance in nature. Lime is never found free, but usually combined with Carbonic acid forming varieties of Carbonates of Lime. It is a greyish white Solid, having an alkaline taste, barely Soluble in water, It is Soluble in 750 times its weight in Cold water & still less so in warm water. It is officinal in all pharmacopaeias. Lime water has Sp. gr. 2.3. When perfect it is transparent & has a Soapy disagreeable taste. When exposed to air a film is formed. Lime has a strong attraction for Carbonic acid & forms a test for that acid. Oxide of Calcium is unimportant. Sulphuret of Calcium is unimportant. The phosphuret of Calcium when thrown into water produces a phosphuret of hydrogen, Spontaneously inflammable. With Chlorine it forms an officinal Compound Chloride of Calcium made by saturating hydrochloric acid by means of Carbonate of Lime, when the products formed are Chloride of Calcium & water. It is a bitter white Substance, Somewhat Acid & Excessively deliquescent. When dissolved in water an officinal Compound is

formed used in Scrofula; the Liquor Calcii Chloridi.

Calcium Combines with Fluorine as Fluoride of Calcium (fluorspar) which occurs naturally. It is valuable in the arts & its use is to form ornaments by turning. It is used as a flux to promote the melting of other substances. It is used to obtain fluohydric acid. Protoxide of calcium is a salifiable base. It exists in hydrate of lime which is not officinal. This is Slacked lime. Nitrate of Lime is formed in the nitre beds. Carbonate of Lime forms 4 officinal varieties ~~see~~ ^{see} Creta or chalk. It is reduced to a fine powder which is diffused in water & then allowed to stand; the milky water is drawn off, & in a week or so, the particles will fall from the water & form the finer powder; & when thus treated it forms the creta preparata of the U.S. pharmacopoeia. The 2nd form is Marmor (marble). This is a pharmaceutical ingredient used to form carbonic Acid in certain preparations. The 3rd variety is Testa (oyster shell), Carbonate of lime associated with a little animal matter. It is ground to a fine powder & is called Testa preparata. The 4th variety

is made by precipitation: *Calcis carbonas precipitatus US*

This is a delicate & impalpable powder. Sulphate of lime
Gypsum, Melanite, Alabaster. This is not officinal.

Gypsum is an hydrous Salt ground to powder & calcined.
The water is driven off & the remainder is plaster of Paris.

Sulphate of lime exists without water as Anhydrite.

Phosphate of lime occurs in nature as the incombustible
portion of bone, & it is called bone phosphate of lime. Thus
obtained it contains also carbonate of lime, which at a
higher temperature is formed into lime. Officinal in the
Dublin Pharmacopoeia is *Calcis phosphas precipitatum*
which is made by dissolving calcined bone in muriatic acid.

Ammonia is added to the solution & the bone phosphate of lime
falls down in a powder. In the London pharmacopoeia
there is *cornu Uetum*, burnt horn, made from burning
the horn of the Stag forming bone phosphate of lime & lime.

Calx Chlorinata, chlorinated lime is officinal in *US*
pharmacopoeia. It is the bleaching powder or bleaching
Salt employed in bleaching, as well as in medicine.

It is assumed to be a hypochlorite of lime & it is made by placing in certain sections of Sandstone shells containing slacked lime. A stream of Chlorine is then passed into the chamber, & absorbed, the hydrate of lime becoming saturated, the chlorinated lime is obtained. There is a solution of this made officinal by the Dublin Colleges. It is used externally as a vesicant, & internally as an astringent & a stimulant.

Lime is tested by oxalic acid. In the US pharmacopœia there is an officinal preparation Potassa Cum Calce which is the famous Vienna powder used by Surgeons.

XVIX. Magnesium Mg. 12 - Silver white metal. Sav 1808. Bap 1/30

Magnesia US (protoxide of Magnesium) MgO $12 + 8 = 20$

(Chloride of Magnesium) MgCl

Magnesia Sulphas US (epson salt) $\text{MgO}, \text{SO}_3 + 7\text{HO}$

MgCl and $\text{HO}, \text{SO}_3 = \{\text{MgO}, \text{SO}_3\}$ and HCl

Pulvis Salinus Compositus Ed

Neutral Phosphate of Magnesia $\text{HO}, 2\text{MgO} + \text{PO}_5 + 14\text{HO}$

$\text{HO}, 2\text{NaO} + \text{PO}_5$ and $2(\text{MgO}, \text{SO}_3) = \{\text{HO}, 2\text{MgO} + \text{PO}_5\}$ and $2(\text{NaO}, \text{SO}_3)$

Table continued on next page

Phosphate of Magnesia & Oxide of Ammonium

[ammoniac-magnesian phosphate] $\text{NH}_4\text{O}, 2\text{MgO} + \text{PO}_5$
 $\text{HO}, 2\text{NaO} + \text{PO}_5$ and $2(\text{MgO}, \text{SO}_3)$ and $\text{NH}_4\text{O} - \{ \text{NH}_4\text{O}, 2\text{MgO} + \text{PO}_5 \} \& 2(\text{NaO}, \text{SO}_3) + \text{HO}$

Magnesian Carbonate US $4(\text{MgO}, \text{CO}_2) + \text{MgO}, 2\text{NH}_3 + 4\text{HO}$ (Furnes)

Hydrate of Magnesia - MgO, HO

MgO, SO_3 and $\text{KO}, \text{HO} = \{ \text{MgO}, \text{HO} \}$ and KO, SO_3

Magnesia is found as a Carbonate in the Earth, as the Silician hydrate of Magnesia; in dolomite, in Seawater & always as a constituent of certain minerals of unctuous feel, greenish fibre color, fibrous texture & silky lustre. Effusing carbonate of Magnesia to Calcination, Magnesia is formed, & carbonic acid driven off. Thus obtained it is a white substance lighter than flour Sp. gr. 2.3. There is a heavy magnesia formed by a peculiar process. Chloride of Magnesium exists in Sea water. Magnesia has alkaline properties. It unites with water taking up about 18% forming a sort of a hydrate. Magnesia is a salifiable base forming various salts. Sulphate of Magnesia is commonly called Epsom Salt & is obtained in various ways. Formerly it was

obtained from the waters of the Epsom Spring in England. It
 is formed from the bittern of Sea Salt works. There remains a
 Chloride of Magnesium in the bittern upon which is poured
 Sulphate of water when hydrochloric acid is given off. It is
 obtained principally from the mineral Magnesite abundant
 near Baltimore which is treated with dilute Sulphuric acid
 A solution is formed of Sulphate of Magnesia which by proper
 Concentration forms the proper Salt. It is usually crystallized
 in minute crystals, though sometimes it crystallizes in four
 sided prisms. It is efflorescent & gains strength by keeping,
 parting with its water of crystallization. There is a neutral
 phosphate of Magnesia, a tribasic phosphate, made by
 adding 2 equivalents Sulphate of Magnesia to 1 eq of the
 neutral phosphate of Soda when a double decomposition
 takes place forming this Compound & Sulphate of Soda. There
 is a phosphate of Magnesia & oxide of Ammonium, the
 ammoniaco-magnesian phosphate which is one variety of
 the urinary Calculus. It may be formed by adding to the
 neutral phosphate, the oxide of Ammonium.

Magnesia carbonas is lump Magnesia or Magnesia; also called Magnesia alba. It is generally a compound of the Carbonate & hydrate of Magnesia. It is formed by double decomposition between Carbonate of Soda & Sulphate of Magnesia. It is a light white Substance very light for its bulk.

Hydrate of Magnesia is combined with it. Hydrate of Magnesia is produced by adding hydrate of potash in solution to a solution of Sulphate of Magnesia. The hydrate is precipitated in a gelatinous form & Sulphate of potash remains in solution.

{ Barium Ba. 69. Silver white metal Melting point at heat }
 { Protoxide of Barium (baryta) BaO - 69 + 8 - 77 - Scheele 1774 }

Barium is a metal occurring in the Earth oxydized as Baryta in two forms (Carbonate of Baryta (witherite) & as Sulphate of Baryta or heavy spar. It may be obtained from either of these Salts. Acting upon the Sulphate of Baryta at a high heat by Charcoal, we get Sulphuretted barium. Add to this Muriatic Acid & we get chloride of Barium; Act on this by the Carbonate of an alkali & we get Carbonate of Baryta. Acting on this at a high

heat we get Baryta with hydrate of baryta. It may also be
 obtained from the other Salt. It is like lime when treated
 with water. It dissolves in 20pts Cold & 2pts boiling water.
 A hot saturated solution by refrigeration produces it in crystals.
 A cold saturation produces baryta wash. Baryta is the
 protoxide of Barium. It was discovered by Scheele in 1774, when
 it was considered to be an element. There is a chloride of
 barium officinal in solution in US pharmacopoeia as
Siquor Barii Chloridi. Baryta is a salifiable base &
 forms Nitrate, Carbonate, & Sulphate of Baryta. The two
 latter occur naturally. They are both officinal as they
 are employed to obtain chloride of barium. The Salt
Baryta Carbonas alone is officinal in US pharmacopoeia
 To obtain the Carbonate artificially is unnecessary.
 The salts of Baryta are poisonous except the Sulphate
 of Baryta, & the antidote is the Sulphate of Magnesia, or
 the Sulphate of Soda. The Sulphate of Baryta is insoluble
 in the acids present in the stomach & it is for this
 reason that it is not poisonous

[L] Strontium - Sr. 44. Brassy, yellow, ductile metal Sp. gr. 2.5

Protoxide of Strontium (Strontia) SrO $44 + 8 = 52$

Dutoxide of Strontium SrO_2

Chloride of Strontium $\text{SrCl} + 91 + 0$

Salts of Strontia {
 Carbonate of Strontia SrO, CO_2
 Sulphate of Strontia SrO, SO_3
 Nitrate of Strontia SrO, NO_5

Strontium forms two Combivalencies with oxygen. Protoxide of Strontium, (Strontia) was discovered in 1792 by Dr Hope of Edinburg. When sufficiently heated Strontium burns with a white light into Strontia. Strontia exists in nature combined with Sulphuric & Carbonic acids, in the minerals Celestine & Strontianite. With Nitric it forms Nitrates of Strontia.

Disappating this, the earth is obtained from native Carbonate.

If the Sulphate of Strontia be powdered & mixed with charcoal & then exposed to great heat, Sulphuret of Strontium is formed, then act on this with Nitric acid forming a Nitrate of Strontia & then proceed as above. SrO_2 as well as several Sulphurets of Strontium are unimportant.

Submitting some Sulphuret of Strontium to the action of
Muriatic acid Chloride of Strontium is formed & Sulphuretted
hydrogen goes off in effervescence. Strontia is analogous to
Bartha although its Salts are not poisonous. The Nitrate of
Strontia do not occur native, but is obtained artificially from
the native Salts. The Salts of Strontia & Bartha are capable of
dissolution in alcohol. When set fire to the Solution of Bartha
burns with a yellow flame & that of Strontia with a red flame —

Aluminium. Al. 14. Silver white metal malleable, ductile
& tenacious. Sp gr. 2.5... Al_2Cl_3 and $3Na = \{sal\}$ and $3NaCl$
 Sesquioxide of aluminium (alumina) Al_2O_3

Salts of alumina $Al_2O_3, 3SO_3 + 18HO$

Alumen US (alum) Sulphate of alumina & potassa
Alumen Exsiccatum US = Pulvis aluminis compositus Ed
Cataplasma aluminis Alut

$Al_2O_3, 3SO_3 + 10, SO_3 + 24HO = potassa alum$

$Al_2O_3, 3SO_3 + 2H_4O, SO_3 + 24HO = ammonia alum$

Aluminium is a basifiable metal. It has been ob-
tained by the action of potassium on the Sesquichloride of

Aluminium. It is about $\frac{1}{4}$ the weight of Silver. It is more Sonorous than the best bell metal. It forms but one Combination with oxygen, the Sesquioxide of aluminium (pure clay) alumina. The metal is obtained in greater quantities by using Sodium instead of Potassium. The principal salt of alumina is a compound salt, the Sulphate of alumina and potash. It crystallizes in octahedrons. The Sapphire is crystallized alumina colored blue by a minute portion of metallic oxide. The oriental ruby is also crystallized alumina colored by another substance. Sometimes alumina is found crystallized & perfectly transparent as Emerald. Sometimes it is opaque & when powdered forms Emery used for polishing.

There is another alum whose oxide of Ammonium exists instead of oxide of potassium, but its medical properties are similar to the other. Alum when exposed to gentle heat, melts in its own water of crystallization, & when further heated, the water goes off & it forms alumina exsiccata. When allowed to cool after melting it forms a transparent mass, uncrystallized, known as Rock Alum.

Glucinum is found as an earth in Brazil.

Zirconium is a metal extracted from its oxide Zirconia, which is obtained from the mineral zirconite.

[II.] Iron. Fe. 28. Sp.gr. 7.7. Fuses at a white heat. Malleability greatest.

Ferri Filum US Ferri Famenta US Ferri pulvis US (eductionum)

Iron with O. $FeO - Fe_2O_3$. Magnetic black iron $FeO + Fe_2O_3$ (the

Ferri Oxidum Magneticum Deb) Ferric acid FeO_3

Ferri Oxidum Hydratum US Ferri Peroxydum Deb

Ferri Oxidum Nigrum Ed $2FeO + Fe_2O_3 + 2H_2O$

Ferri Sulphuratum Ed + Deb $FeS - Fe_2S_3 - FeS_2$ (cubic pyrites)

Magnetic pyrites $5FeS + Fe_2S_3 - Fe_6S_8 - Fe_2Cl_3$

Tinctura Ferri Chloridi US Ferrum Ammoniacum US

Tinctura Ferri Ammoniochloridi. Lond ---

Ferri Iodidum US FeI

Liquor Ferri Iodidi US - Sympus Ferri Iodidi. Lond. Ed. Deb

$FeBr$ - Pillula Ferri Iodidi US

Iron with Carbon - Cast iron & Steel.

Iron occurs sometimes native & it is then thought to be of meteoric origin. It also occurs in nature sesquioxide

and also an hydrated Sesquioxide. It also occurs mixed with clay. It also exists Combined with Sulphur, and it also exists as a Carbonate of the Protoxide of Iron. Iron is very ductile and malleable. It takes fire in air when sufficiently heated. It is officinal in various forms. Iron unites with Oxygen. The protoxide of iron is of no consequence & it cannot be readily obtained pure and dry. The Sesquioxide is officinal in both the hydrated and in the anhydrous state. Hydrated Sesquioxide of iron is an antidote for the poison of arsenious acid. It is kept in a pulpy state under water.

LII. $\text{Fe Cy} - 2 \text{Hcy} + \text{Fe Cy} -- \text{m}_2 \text{Fe Cy}_3 - \text{Ferrocyanogen Fe Cy}_3 \text{ or}$
 $\text{Cy}_4 - \text{m}_2 \text{Cy}_4$

Potassii Ferrocyanuratum us $\text{K}_2 \text{Cy}_4 + 3 \text{H}_2 \text{O}$

Ferrocyanuret of lead -- $\text{K}_2 \text{Cy}_4$ and $2(\text{PbO}, \text{m}_2) = \{\text{Pb}_2 \text{Cy}_4\} + 2(\text{m}_2 \text{m}_2)$

Ferri Ferrocyanuratum $\text{Fe}_4 \text{Cy}_4 + 6 \text{H}_2 \text{O}$

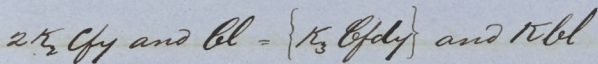
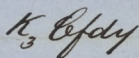
$3 \text{K}_2 \text{Cy}_4$ and $2(\text{Fe}_2 \text{O}_3, \text{SO}_3) = \{\text{Fe}_4 \text{Cy}_4\}$ and $6(\text{K}_2 \text{SO}_3)$

Ferrocyanuret of hydrogen $\text{H}_2 \text{Cy}_4$

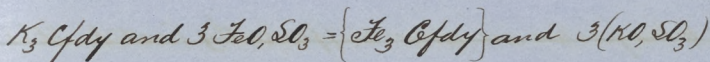
$\text{Pb}_2 \text{Cy}_4$ and $2 \text{NS} = \{\text{H}_2 \text{Cy}_4\}$ and 2PbS

$\text{m}_3 \text{Cy}_4 = \text{Cy}_4 - \text{Cy}_4 - \text{m}_3 \text{Cy}_4$

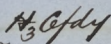
Ferridcyanuret of potassium



Ferridcyanuret of iron (Turnbull's Prussian blue) $Fe_3 Cfy$



Ferridcyanuret of hydrogen



Metallic Iron combines with cyanogen as the protocyanuret of Iron which will unite with Cyanurets of other metals & the cyanurets of Hydrogen. The Symbol for a metal is M. The compound radical Cyanuret of iron is generally combined with 2 eqs. of the metal & is called ferrocyanogen & has a separate Symbol Cfy. Official ferrocyanuret of potassium is made by melting refuse animal matter rich in Nitrogen with Carbonate of potassa in the form of pearl ash in iron vessels, & the resulting mass treated with water. This solution is concentrated & when cooled it forms beautiful yellow crystals of the salt. This is used extensively in the arts & is manufactured by the chemist on a large scale. The salt is crystallizable in tables. It is soluble in water & insoluble in alcohol. It has a hot & somewhat bitter & saline taste. From this salt prussic acid

is obtained as well as the poisonous cyanuret of potassium. We also get from it the ferrocyanuret of iron the famous Russian blue. Hydrogen seems to act towards this compound like a metal & the compound is called ferrocyanuret of hydrogen which acts as an acid, & its proper name is Hydroferrocyanuric acid.

It is formed from Sulphuretted hydrogen & cyanuret of lead, forming this acid & Sulphuret of lead (See Equation in table) 2 eq. ferrocyanogen will combine with 3 eqs. of a metal in a different combination from the others, & the new compound radical is called ferridcyanogen & the symbol is C_6F_3 .

The ferridcyanogen forms with potassium the ferridcyanuret of potassium formed by acting on 2 eqs ferrocyanuret of potassium with a stream of chlorine equal to 1 eq of chlorine; & the substances obtained are ferridcyanuret of potassium & chloride of potassium which remains in solution. This is a curious salt having ruby red lustrous crystals. A solution of this salt will form ferridcyanuret of iron (Turnbull's Russian blue) by precipitating a solution of the Sulphate of the protoxide of iron as seen in the table.

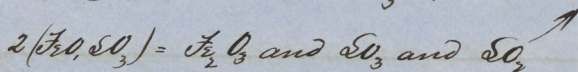
The ferri cyanuret of hydrogen is formed by acting upon ferri cyanuret of lead by *Eq.* Sulphuretted hydrogen. *Eq.*

H_2 Cfdy and $3PbS = \{H_2 Cfdy\}$ and $3PbS$ forming this Compound and Sulphate of lead. The ferri cyanuret of hydrogen is an acid & should be called Hydroferri cyanuric acid. Hydroferri cyanuric acid is a white crystalline Solid, perfectly inodorous; it has all the combinations of Prussic acid but has none of its poisonous properties. Hydroferri cyanuric acid is a brown crystalline Solid.

LII Ferri nitrate of Sesquioxide of iron $Fe_2O_3, 3NO_5$

Liquor Ferri Nitricus US

Ferri Sulphas US (green vitriol) $FeO, SO_3 + 7H_2O$



Ferri Sulphas Exsiccatum Ed Allulæ Ferri Sulphatis Ed

Ferri Sulphas Granulatum Ed $Fe_2O_3, 3SO_3$

Ferri Phosphas US ~~140, 2~~ $140, 2FeO + PO_5$

Ferri Subcarbonas US Fe_2O_3 with a little FeO, CO_2

Carbonate of Sesquioxide of iron - Fe_2O_3, CO_2 - Allulæ Ferri Carbonatis US

Ferri Carbonas Saccharatum - British College

Protoxide of iron forms several salts. Ferritrato official, &
 Sulphate of the protoxide of iron (green vitriol) made by
 dissolving iron in Sulphuric acid largely diluted. On
 exposure to air it effloresces forming a Subsulphate of the
 Sesquioxide of iron. Driving off the $7\frac{1}{2}$ gr Aqua it becomes the
 Ferri Sulphas Exsiccatus official in the Ed. pharmacopoeia,
 forming a peculiar pill also official in the Ed. pharmacopoeia.
 The dry Sulphate of protoxide of iron distilled at a high heat
 will give burning oil of vitriol of Rudhausen in Germany. It
 has many pharmaceutical uses, & is used extensively in the
 arts. There is a preparation peculiar to the Dublin College,
 granulated Sulphate of protoxide of iron. This is made by
 instead of crystallizing the solution of iron in oil of vitriol, fil-
 tering it while hot into a certain amount of alcohol or
 rectified spirits which dissolves any trisulphate present,
 & the excess of acid takes up any Sesquioxide of iron. When
 cooling is stirred up assiduously it crystallizes in granules,
 & any existing moisture is taken out by blotting paper.
 Phosphate of iron is obtained from a solution of the

sulphate of protoxide of iron, & the neutral tribasic phosphate of Soda. A precipitate is formed, the Subcarbonate of Iron. This is a sesquioxide of iron associated with a little Carbonate of protoxide of iron. It is made by double decomposition between Sulphate of protoxide of iron & Carbonate of Soda, when this substance precipitates & Sulphate of Soda remains in solution. Carbonate of protoxide of iron is obtained from Sulphate of protoxide of iron dissolved in a solution of Sugar & water, & Carbonate of Soda dissolved likewise in Syrup, & the reaction protects the precipitate from absorbing Oxygen & it remains Carbonate of protoxide of iron. The precipitate is mixed with honey to the consistence of pills forming *pillule ferri Carbonatis* *U.S. pharm.* *Copaea*; an equivalent preparation exists in the British College's *Ferri Carbonas Saccharatum*, when it is mixed with Conserv. of roses. Iron may be tested by the ferrocyanuret of potassium forming Russian blue, and also by Tincture of galls which form a black precipitate equivalent to ink. Iron in its different forms is administered as an admirable tonic.

Manganese. Mn . 28. Sp. gr. 8. Discovered by Scheele & Gahn 1774

Mn with O forms 5 oxides and 2 acids

5 oxides are MnO - MnO_2 - Mn_2O_3 - $\text{MnO} + \text{Mn}_2\text{O}_3$ - Mn_4O_7

2 Acids are MnO_3 - MnO_4 — Mn_4O_7 is bauxite

Manganese is contained in many minerals, but the principal one is, Protoxide of Manganese or Black oxide of Manganese. When the ore is powdered it forms Soldes Mangan. Ecr. It forms with oxygen 5 oxides viz; protoxide, deutoxide, Sesquioxide, red oxide of manganese, & bauxite, a mineral containing manganese in an irregular form. Empirical formula is Mn_4O_7 . It forms also 2 acids, a tetraxide of manganese, or Manganic acid; & an irregular acid hypermanganic acid. Black oxide of manganese is used in the arts. It develops chlorine from chloride of Sodium to make bleaching powder. It is used to obtain oxygen by exposing it to heat, when it becomes red oxide at a dull red heat; & at a white heat, a Sesquioxide is formed. Protoxide of manganese is present in the salts of Manganese & it is therefore basifiable.

Sulphur. Afterwards it is ignited with charcoal to take away oxide of zinc, & metallic zinc is developed. At common temperatures it is not malleable to any extent, but at 300° it can be rolled out into sheets. The impure zinc of commerce is called Spelter. Zinc is a bluish white metal presenting a hacked fracture. To get it pure, dissolve Spelter in dilute muriatic acid & precipitate it by carbonate of soda. Ignite this with charcoal & metallic zinc will be obtained pure. The metal is officinal as Zincum. With oxygen, it forms a protoxide of zinc & a peroxide of zinc, of imperfect composition. Protoxide of zinc is officinal. An impure oxide of zinc was formerly officinal in the Ed College as Linty. It originates in a concretion found in the chimneys of furnaces employed to smelt lead containing zinc. Zinc forms with chlorine an officinal compound made by dissolving metallic zinc in muriatic acid. Hydrogen is given off in effervescence & there is left a solution of chloride of zinc which is evaporated to dryness, & fused, & then we obtain the Zinc Chloridum *US*

which is very deliquescent. It was formerly called butter of
 zinc. There is an iodide of metallic zinc. Chloride of zinc is
 an important caustic. Iodide of zinc is formed by digesting
 zinc in excess with iodine infused in water, & the solution is
 evaporated to dryness. It is very deliquescent. It is not offic-
 inal although medicinally employed occasionally by some
 in gonorrhoea and leucorrhoea. Protoxide of zinc is a sali-
 fiable base forming salts with acids. Sulphate of protoxide of
 zinc is made on a large scale from blende which is pounded,
 & exposed to air & moisture, and by double decomposition the
 salt is formed. It generally contains foreign metals present in
 the mineral itself, principally iron. It is commercially
 called white vitriol and is not fit for medicinal purposes.
 This salt may be made by dissolving metallic zinc in dilute
 sulphuric acid. The zinc is oxidized & the sulphuric acid unites
 with it, while hydrogen is given off. The white vitriol of com-
 merce may be purified by repeated solution & crystallization
 which must be continued till a sample of the solution will
 not give a black precipitate with tincture of galls, or a

precipitate inclining to black, but this is an imperfect method.

White vitriol may be purified by inserting in the solution, a rod of pure metallic Zinc. It is a white salt, soluble in $2\frac{1}{2}$ parts of Cold water & is more soluble in boiling water. It crystallizes in four-sided prisms containing 7 $\frac{1}{2}$ of water, when crystallized from a cold, & 3H₂O when crystallized from a hot solution. Carbonated Calamina is official in the US pharmacopæia as Calamina preparata in fine powder.

Cadmium - Cd - Sp. gr. 8.6

CdO — CdO, SO₃

Cadmium looks not unlike tin & it is as volatile as mercury. It forms a protoxide of Cadmium. There is also a Sulphate of protoxide of Cadmium used in ophthalmic surgery.

LV. Lead. At. 104. Sp. gr. 11.4. Fusing point 612°

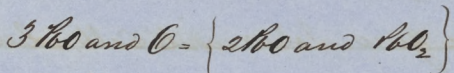
It with O forms four regular oxides Pb₂O; PbO; Pb₂O₃ and PbO₂. PbO and (Pb, Cl = {PbO₂} and Ca Cl

(a) Plumbi oxidum Emivitreum US (Litharge) PbO

Emplastum Plumbi US melted with resin forms

Emplastrum Resinae US

(b) Plumbi Oxidum Rubrum Ed $2 PbO + PbO_2$



PbS PbCl = PbO, NO_2 and $NaCl = \{ PbCl \}$ and NaO, NO_2

Plumbi Iodidum US PbI = PbO, NO_2 and $HCl = \{ PbI \}$ and NO, NO_2

Unguentum Plumbi Iodidi Lond

Plumbi Nitras US $PbO, NO_2 = \{ PbO, SO_3 - PbO, NO_2 \text{ and } NaO, SO_3 \}$

Plumbi Subnas US $2(PbO, CO_2) + PbO, H_2O = \{ PbO, SO_3 \}$ and NaO, NO_2

Lead is chiefly obtained from the ore Galena, Sulphuret of lead. The ore is roasted & the Oxygen resulting is treated with Charcoal at a low red heat, and lead is obtained as a soft bluish-white metal, not tarnishing much in air, but in combination with air & water. When heated after melting, it will burn giving copious blue flames. It is slightly ductile. It forms four regular oxides with oxygen. A hydrated peroxide is obtained by precipitating Nitrate of protoxide of lead by an excess of ammonia. Massicot is formed by melting lead, then scraping off the pellicle & continue the heat, & scrape off each pellicle as it is formed & the whole forms a mass

called drop, which exposed to heat & gradually stirred, will be
 formed into Commercial protoxide of lead. Nutoxide of lead
 is formed from the protoxide digested in chlorinated lime.
 It is a brown oxide. Litharge and red lead are irregular
 oxides of lead. Litharge is officinal as *Plumbi Oxidum Semi-*
vitrum. Litharge is obtained from certain galenas Con-
 taining some silver, & the lead also contains some silver & is
 called Argentiferous lead which is melted in an oval dish
 made of bone, ashest & a stream of air is blown over the
 melted lead by a pair of bellows. The lead is oxidised but
 not the silver, & by continuing the process the silver globules
 are left behind. The semivitrified oxide of lead blown off is
 Litharge. Litharge is used to make an officinal plaster
Emplastrum Plumbi made by the action of olive oil & litharge
 with water. This is the basis of most of the plasters. When
 melted with resin it forms the officinal adhesive plaster.
 Red lead is often called *minium* & is obtained by
 exposing massicot to heat & air in an oven, & it is stirred
 up until it gets a bright red color. Iodide of lead is

official. It is made by adding iodide of potassium to nitrate of the protoxide of lead. Protoxide of lead is basifiable & forms numerous salts. Nitrate of protoxide of lead is official. It is made by dissolving metallic lead in Nitric Acid & the substance is obtained in crystals. Sulphate of protoxide of lead is not official.

Carbonate of protoxide of lead is official. It is obtained from the reaction between Nitrate of protoxide of lead & Carbonate of potash.

Tin is used to form only one official preparation Stannii pulvis, metallic tin in powder. It exists mineralized usually as an oxide, rarely as a sulphide. It has a silver white color.

It is formed from the oxide by heating with charcoal. Its fusing point is 442° . It is a soft, malleable & ductile metal Sp gr 7.3

Symbol Sn Eq. 59. If we melt the metal & pour in hot water, & while cooling it, rub it up with a pestle & granulate it, & subject this to a sieve, the finer particles will be the Stannii pulvis of the pharmacopoeia used as a vermifuge. Protochloride of tin is a test for gold and mercury. Tin is used extensively & the arts & many domestic articles are manufactured from it.

LVI. Copper. Cu. 32. Sp. gr. 8.9. Fusing point a highest red heat. It occurs oxidized in ruby copper. It occurs combined with Sulphur in the pyrites, with carbonic acid forming malachite. It is obtained chiefly from the native Sulphuret by roasting & then extracting Oxygen by means of charcoal. This is commercial copper which contains $1\frac{1}{2}\%$ impurities. To get it pure dissolve it in hydrochloric acid & dip a rod of iron in the solution, & on this rod the pure metallic Copper will be precipitated & deposited, & then it can be scraped off. It is a reddish metal. Copper forms with oxygen, deuteroxide of Copper, suboxide of copper Cu_2O , CuO the basic oxide, protoxide of Copper. Cu_2Cl and $\text{HO} = \{\text{Cu}_2\text{O}\} + \text{HCl}$. This occurs native as ruby Copper ore. It is a red powder; of an orange color when in the state of hydrate. Protoxide of Copper CuO is formed from CuO , SO_3 and HO , $\text{CO}_2 = \{\text{CuO}, \text{CO}_2\}$ and HO, SO_3 . Igniting this precipitate CO_2 will go off & leave CuO . By igniting CuO , NO_3 - we also get CuO . It is a black powder. Cu with S forms Cu_2S and CuS , Copper pyrites. Cu_2S and FeS_3 . Cu with Cl forms Cu_2Cl and CuCl . $\text{CuO} + \text{HCl} = \text{CuCl}$ and HO in green deliquescent crystals. By exposing it

to a heat of 400° it loses Chlorine & forms Cu_2Cl thus $\text{CuCl}-\text{d} =$

Cu_2Cl Nitrate of protoxide of Copper CuO, NO_3 is made by pouring on metallic Copper NO, NO_2 diluted with 3 parts its weight of H_2O . Nitric oxide is formed & unless closely collected, it is converted into fumes. It is deliquescent & of a beautiful blue color. It has a metallic, styptic, persistent taste. It is soluble in water. Ammonia precipitates protoxide of Copper which an excess dissolves. Cupri Sulphas (blue vitriol) $\text{CuO}, \text{SO}_3 + 5\text{H}_2\text{O}$ is made by boiling 2SO_3 and $\text{Cu} = \text{CuSO}_3$ and SO_2 . It is soluble in 4 parts of cold & $3\frac{1}{2}$ parts boiling water. It is slightly efflorescent. Cuprum Ammoniatum is made by rubbing together 2 parts CuO, SO_3 and 3 parts NH_4O ($\text{CO}_2 = \text{CuO}, \text{CO}_2$ and $\text{NH}_4\text{O}, \text{SO}_3 + \text{NH}_4\text{O}, \text{CO}_2$). This is of an azure blue color & is dried on blotting paper. It has a metallic styptic taste. It is soluble in water & in alcohol. Carbonate of protoxide of Copper

CuO, CO_2 is made from CuO, SO_3 & $\text{KO}, \text{CO}_2 = \{ \text{CuO}, \text{CO}_2 \} 3\text{KO}, \text{SO}_3$ this is the verditer of Commerce. Malachite is a Bicarbonate of protoxide of Copper. The tests for Copper are, ferrocyanuret of potassium, which gives a beautiful brown

precipitate. $2(\text{CuO}, \text{SO}_3) + \text{K}_2 \text{Cf}_4 = \{\text{Cu}_2 \text{Cf}_4\}$ and $2(\text{K}_2\text{O}, \text{SO}_3)$

Copper with zinc forms brass; with tin it forms bell metal, bronze, Cannon metal &c

Bismuth. Bi. 213. Sp.gr 9.8. fusing point 476°

Bismuthum US

A metal of a reddish white color, not ductile, not malleable, but crystallizable. With oxygen it forms BiO_2 and Bi_2O_3 . With chlorine it forms BiCl_3 . BiCl_3 has acid properties. It unites with nitrogen forming $\text{Bi}_2\text{N}_2\text{O}_3$. Ternitrate of teroxide of Bismuth. Bismuth Subnitras $\text{Bi}_2\text{O}_3 \cdot 3\text{NO}_2$ formed by adding a little Ternitrate of much water. Both of these are white salts.

LVII. Mercury - Hg - 200 Sp.gr (liquid 13.5) (solid 14.4)
solidifies at 39° below zero - Boils at 662°

Hydrargyrum US.

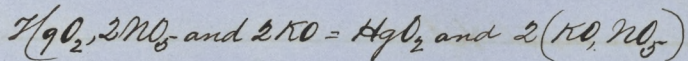
Hg with O. HgO - HgO_2 - Ash colored HgO

HgCl and $\text{CaO} = \{\text{HgO}\}$ and CaCl

Black HgO - Hydrargyri Oxidum Nigrum US

$\text{HgCl} + \text{KO} = \{\text{HgO}\}$ and KCl

Protoxide, obtained (a) By heat alone (b) by precipitation
(c) By Nitric acid



Hydrargyri Oxidum Rubrum Us }
(Red precipitate) } $-\text{HgO}_2, 3\text{NO}_2-$

Unguentum Hydrargyri Oxidi Rubri Us $\frac{3i}{s}$ to $\frac{3j}{s}$ { Simple
ointment

Hg with S = HgS , HgO_2 — HgO_2 and $10\frac{1}{2}\text{S}$

Hydrargyri Sulphuretum Rubrum Us (cinabar) $\frac{\text{HgS}_2}{\text{HgS}_2}$

Hydrargyri Sulphuretum nigrum Us (Ethiops mineral) $\text{HgS}_2 + 10\frac{1}{2}\text{S}$

Hg with Cl — Protochloride (calomel) HgCl

Bichloride (corrosive sublimate) HgCl_2

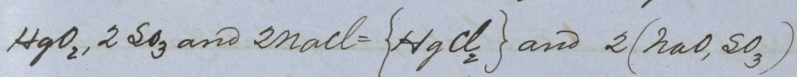
Mercury occurs native, also as Bisulphuret in
Cinnabar & also as protochloride. To obtain it from
native Cinnabar, the ore is distilled with lime in iron
retorts & the liberated mercury is distilled over into
mercury. It is liquid at common temperatures
& is very dense. It solidifies at 39° below 0° & it has
then the appearance of lead. As it occurs in
commerce it is usually pure. The most frequent

impurities found in it are lead, tin, or bismuth. It may
 be purified by Subjection to the action of dilute Sulphur-
 ic acid. Muriatic acid does not act upon it. Cold
 nitric acid & hot nitric acid attacks it. Cold sulphuric
 acid does not act on it; but sulphuric acid hot &
 concentrated dissolves it. With oxygen it forms two
 oxides. Protoxide of mercury is presented in two forms
 one ash colored & the other black. The ash colored protoxide
 is formed by the action of lime water on Calomel as seen
 in the Equation in the table. Black wash is formed
 from 60 grs Calomel added to 1 pint Lime water.
 The black protoxide is officinal. It is formed by acting
 on Calomel with potash. When metallic mercury
 is minutely divided by mechanical means and
 tuturated with the powder of some unctious substance
 it becomes protoxidized to a limited extent.
 When obtained by heat alone, the deutoxide of mercury
 is red precipitate per se or calined mercury
 Deutoxide may also be made by precipitation

by adding a solution of Binitrate of deutoxide of
 mercury to a solution of hydrate of potassa, when
 a yellow precipitate will be thrown down which is said
 to be anhydrous. By adding Bichloride of mercury Hg_2Cl_2
 to lime water Ca , the same precipitate is thrown down
 making the yellow wash (*lotio flava*) of the Surgeon.
 The deutoxide may be obtained by means of nitric acid
 forming red precipitate. To make this you get the
 Binitrate of the deutoxide of mercury. Acting upon
 mercury with an excess of nitric acid, by means of heat,
 you get Hg_2NO_3 . Expose this to a regulated heat
 approaching to redness, and the nitric acid is
 dissipated, leaving the deutoxide of mercury in
 beautiful red scales. This is officinal & is used to make
 an ointment 13 red precipitate to ℥ss simple oint-
 ment. With Sulphur Mercury forms 2 regular
 and one irregular Sulphuret. The Bisulphuret
 & irregular Sulphurets are officinal. The protosulphuret
 is formed by adding a solution of Sulphate of ammonium

to a solution of nitrate of the protoxide of mercury. By this, there is formed a black precipitate & also nitrate of oxide of ammonium. It is not officinal. The Bisulphuret is made by melting 1 $\frac{1}{2}$ Sulphur & adding 6 pts metallic mercury. When heat is applied this will volatilize & Condense again & the product is sublimed, & this is artificial or fictitious Cinnabar. Vermillion is formed from native Cinnabar. The irregular Sulphuret (Ethiops mineral) is made by rubbing equivalent weights of Sulphur & mercury until the globules disappear & it forms a black Compound, containing a great excess of Sulphur. There are two Chlorides of Mercury, protochloride of mercury (Calomel) & Bichloride of mercury (Corrosive sublimate) The latter is made from Bisulphate of dentoxide of mercury which is obtained by acting on mercury with an excess of boiling or very hot Sulphuric Acid. By acting on this with 2 eq Chloride of Sodium, there will be formed

Bichloride of mercury & Sulphate of Soda

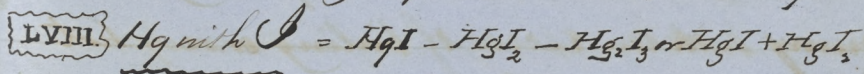


This mixture is subjected to a subliming heat.

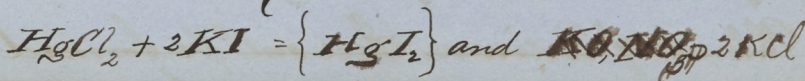
After the Sublimation, Glauber's Salts is left.

Corrosive Sublimate is white, heavy & crystallized. It is soluble in 16 parts Cold water & 3 parts hot water. It has an enduring metallic taste. In an aqueous solution it has a tendency to decompose & deposit Calomel & therefore Chloride of Ammonium is added in equal weight with the Corrosive Sublimate. This forms the *Liquor Hydrargyri Bichloridi* of the London pharmacopœia. Corrosive Sublimate is a violent poison & its antidote is white of egg.

Calomel may be obtained by rubbing up Salt with monosulphate of protoxide of mercury, which is obtained by rubbing $\text{Hg}_2, 2 \text{SO}_3$ with 12 $\frac{1}{2}$ Mercury



Hydrargyri Sodidum Sublimund is HgI_2



Hydrargyrum Iodidi US - HgI

HgO, NO_3 and $KI = \{HgI\}$ and KO, NO_3

Unguentum Hydrargyri Iodidi US London

Unguentum Hydrargyri Iodidi Rubri - Dublin

Hydrargyri Cyanuretum US Hg, Cy_2

Four Nitrates $HgO, NO_3 - HgO_2, 2NO_3 - HgO_2, NO_3$ and

$HgO_2, 2NO_3$ with excess of acid

HgO, NO_3 and $NaCl = \{HgCl\}$ and NaO, NO_3

Nitrous Turpeth $3HgO_2, 2NO_3$

Unguentum Hydrargyri Nitratii US (citrine ointment)

Hydrargyri Pernitras Liquor. Dublin

Three Sulphates. $HgO, SO_3 - HgO_2, 2SO_3 - 3HgO_2, 2SO_3$

Hg and $H_2SO_3 = HgO_2, 2SO_3$ and $2SO_2 \uparrow$

Hydrargyri Persulphas, Dublin

Hydrargyri Sulphus Flavus, US (Turpeth mineral)

$3HgO_2, 2SO_3$

Bimide of mercury may be made by rubbing
8 parts of Mercury with 10 parts of Iodine facilitat-
ing the process by Alcohol. Then powder the product

and dissolve it in a boiling saturated solution of salt. On cooling it will form beautiful red crystals. This is the red Iodide & may also be formed by precipitation according to the equation in the table. The protiodide of mercury is official as *hydrargyri iodidi*. It is of a green color & should be called *hy, io- viridi*. It is made by direct combination, between 8 pts mercury & 5 parts of iodine, rubbed together, assisted by a little alcohol. It may be obtained by double decomposition between iodide of potash in solution & the mononitrate of the oxide of mercury. This is of a dirty dull greenish color. In foreign pharmacopœias there are official ointments of the protiodide & biniodide, but there are none in the U.S. pharmacopœia. The sesquiodide is not recognized by all chemists. It is made by adding iodide of potassium to a solution of the

mixed nitrates of the protoxide & of the deutoxide of mercury; these being used in excess. It is of a yellowish color. It does not seem to be a chemical combination & it is an irregular iodide. The Cyanuret of mercury is made by boiling together deutoxide of mercury (red precipitate) and pure Prussian blue (metallic iron & cyanogen). These are boiled in water; bicyanuret of mercury is formed & the other parts are separated by filtration, and by evaporating the solution there are formed crystals of the bicyanuret of mercury in 4 sided prisms. It is very poisonous, but not so much so as Cyanuret of potassium.

There are two salifiable oxides of mercury; protoxide & deutoxide. There are four nitrates, viz: Mononitrate of protoxide of mercury; binirate of deutoxide of mercury; mononitrate of deutoxide of mercury, and Binirate of deutoxide of mercury with excess of acid.

To form mononitrate of protoxide of mercury;
 act on mercury with an excess of nitric acid.
 This is not officinal. All the protoxides are pre-
 cipitated black by solutions of the fixed alkalis.
 With mononitrate of protoxide of mercury
 and a solution of the chloride of Sodium,
 Calomel will be precipitated, & Nitrate of Soda
 will remain in solution, but this is vastly
 inferior to Sublimed Calomel. Binitrate of
 deutoxide of mercury may be obtained in
 solution by acting on metallic mercury with
 an excess of nitric acid & applying heat.
 When this is evaporated by a gentle heat to a
 syrupy consistence & put in a freezing mix-
 ture, the Binitrate will dry out. By simply
 evaporating the solution & allowing it to crysta-
 llize, & then cooling mononitrate of deutoxide
 of mercury will be formed. By adding a solution
 of Binitrate of deutoxide of mercury to water,

a peculiar precipitate is formed called *hitious turpeth* $[3\text{HgCl}_2, 2\text{NO}_2]$ an irregular subsalt. The salts of the deutoxide of mercury, yield with the Caustic alkalies, an orange-yellow precipitate. There is an ointment made from a solution of mercury in nitric acid acted upon by heat called *Citrine Ointment*, official as *Unguentum Hydrargyri Nitratis*. Mix up the solution with lard & neat's foot oil melted together, & kept at a temperature of 200° , stirring the compound. When fresh, this ointment has a light yellow color, & it changes color by keeping becoming somewhat salmon colored. A good ointment can be made without the neat's foot oil. The *Pernitrate* of the deutoxide of mercury with an excess of acid is used to form the *Hydrargyri Pernitras Liquor* (rubbing) made by dissolving mercury in nitric acid, & then

reducing by ~~the~~ evaporation, to a given bulk. This
 is an acid Binitrate of the deutoxide of mercury.
 There are 3 Sulphates — viz; Monosulphate of
 protoxide of mercury; Bisulphate of deutoxide
 of mercury, and Bisulphate of $3HgO_2$. Bisul-
 phate of the deutoxide is used to make Corrosive
 Sublimate. This is made by boiling (4oz) an excess
 of Sulphuric acid on (1oz) metallic mercury, when
 this substance is formed and Sulphurous acid
 is given off. In the Dublin College, this is of-
 ficinal as Hydrargyri Persulphas. It is a
 whitish powder when added to hot water a
 beautiful yellow salt is thrown down. This is
 Called Turpeth Mineral and is officinal in
 the US pharmacopoeia as Hydrargyri
 Sulphas Flavus $3HgO_2, 2SO_3$. Above the
 Turpeth mineral floats an acid salt
 a sort of (sex) subsulphate of the deutoxide
 of mercury. The $3HgO_2, 2SO_3$ is insoluble.

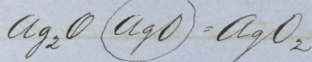
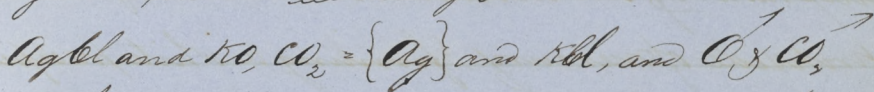
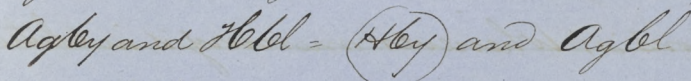
Monosulphate of the protoxide of mercury is made by double decomposition between a Sulphate of an alkali & a nitrate of the protoxide of mercury, forming a white precipitate.

A good test to detect mercurial combinations is; whenever mercury is in solution dip in a bright copper rod & it will be covered with a film of mercury. This is a general test for mercury in solution.

Three tests for Corrosive Sublimate.

- 1st Iodide of potassium added to a solution containing Corrosive Sublimate, throws down Biniiodide of Mercury (red precipitate).
- 2nd. Water of Ammonia throws down an opalescent precipitate.
- 3rd. Protochloride of metallic iron produces a greyish precipitate of metallic mercury. The best solvent for Corrosive Sublimate is Ether.

LIX.

Silver - Ag - 108 - Sp. gr. 105. Argentum USArgenti Oxidum US ~~and AgCl~~AgI in Argenti Cyanuretum USNitrate of protoxide of Silver AgO, NO₅ is
official in two forms(a) Argenti Nitras US. (Crystals)(b) Argenti Nitras Fusus USSulphate = AgO, SO₃

Silver occurs native as the Sulphuret, carbonate, & Chloride of the metal. It occurs chiefly in this Continent. It is generally obtained by amalgamation with quicksilver & the mercury is then distilled over. In Saxony Sulphuret of Silver is treated with Common Salt in order to obtain chloride of Silver, to which is added mercury & iron, and an amalgam is obtained from which Mercury can

be distilled over. In a solution of nitrate of protoxide of Silver, Copper & mercury will precipitate the Silver. The usual way to test Silver as to its purity, is the process called cupellation. When testing Coin or plate take a small weighed portion of the article & melt it with 4 or 5 times its weight of lead; put this alloy in the cup & melt it in a muffle; the lead oxidizes and semivitrifies; the inferior metals in the Silver also oxidize & sink in the pores of the Capsule, while the pure Silver remains as a white globule in the bottom of the Cup. This is then weighed & thus the amount of impurity is discovered. Silver will not oxidize at common temperatures, though it tarnishes from the presence of sulphuretted hydrogen. It is a beautiful white metal; it fuses at a bright red heat & is the next metal in value to gold. When pure and fully melted at a white heat it will absorb oxygen, and when the Silver cools, the

oxygen is driven off. There are several oxides of Silver, Binocide, protoxide & deutoxide. The protoxide is the basic oxide & is officinal. It is made by precipitating nitrate of protoxide of Silver by a hydrate of some alkali. Chloride of Silver may be formed by adding chloride of Sodium to nitrate of the protoxide of Silver, when there is produced a curdy precipitate Nitrate of Soda remaining in solution. This may be fused and when it cools it looks like horn & is called horn Silver. Iodide of Silver is made by adding iodide of potassium to a solution of nitrate of protoxide of Silver when there is formed a sort of yellow precipitate. This is used extensively in dagguerreotyping. *Argenti Cyanuretum* is made by adding Prussic acid to a solution of nitrate of protoxide of Silver (AgO, NO_3). Cyanuret of metallic silver is used to make hydrocyanic acid, by means of muriatic Acid.

Hydrocyanic acid is generated and chloride of metallic silver is precipitated. Nitrate of protoxide of Silver AgO, NO_3 is Lunar caustic & is official in two forms. 1st, as *Argentum Nitratum* & 2nd, as *Argentum Nitratum Fusum*, in which state, the crystals are melted. This salt when given internally should be perfectly pure, but need not be so when used as an escharotic. Nitric acid acts immediately on metallic silver. *Argentum Nitratum* should always be kept in a bottle covered with opaque paper, & this is the article used internally. Nitrate of protoxide of silver is anhydrous. When its administration is continued too long, the patient may have his skin colored to a dark blue tinge which is permanent. It is said that Iodide of silver will produce all the good effects of *Argentum Nitratum* without discoloring the skin, but this is unlikely. Sulphate of protoxide of silver is not official. Cold sulphuric acid

produces no effect on silver leaf, but when hot it dissolves the silver producing the insoluble salt Sulphate of protoxide of silver. 10 parts of water will dissolve but one part of Agl. ~~Sulphate~~
Gold. Au. 199. Sp. gr. 19.3 -

$AuCl_3$ and $6(FeCl_2) = \{Au\}$ and $2(Fe_2O_3, 3SO_3)$ and
 ~~$FeCl_3$~~

Gold is found only native. It may be pure, nearly pure, or alloyed with other metals, chiefly silver. It is the most malleable & ductile metal known. To get pure gold, dissolve gold coin in a combination of Nitric & muriatic acids, obtaining tetrachloride of metallic gold. From this throw down pure gold by means of Sulphate of protoxide of iron. It is best to add the gold solution to the other solution. The reaction is very complicated. The best test for gold in solution is the protochloride of tin, and this gives a purple powdered Cassius -

Platinum - At. 99 - Sp. gr. 21.5

1741

Platinum has a higher specific gravity than gold. It was discovered in 1741 by an Englishman named Wood. It was found in grains having a lustre between that of iron & that of silver.

It is malleable & ductile & quite soft when pure. The grains contain also rhodium, palladium, osmium, iridium, & ruthenium. To get it pure the native grains must be dissolved in nitromuriatic acid, as much as is possible, & that which does not dissolve is platinum residue containing osmium, iridium, & ruthenium.

By adding a solution of bichloride of platinum to a solution of chloride of ammonium, there is formed a precipitate, the double chloride of platinum & ammonium. By heating this to a white heat, all goes off but pure platinum. This metal will weld. Powdered platinum will set fire to a stream of hydrogen.

Rhodium - R-52 - Sp.gr. 106 - Wollaston

Palladium - Pd. 53 - Sp.gr. 11.3 Wollaston

Osmium - Os. 100 - Sp.gr. 10 Tennant

Iridium - Ir. 99 - Sp.gr. 21.8 Tennant & Scottell

Rhodium, is a very hard & brittle metal

Palladium, is a noble metal employed in balances and mathematical instruments.

Iridium is the heaviest metal

A native alloy of osmium & iridium found in the platinum grains, is used in the points of good gold pens.

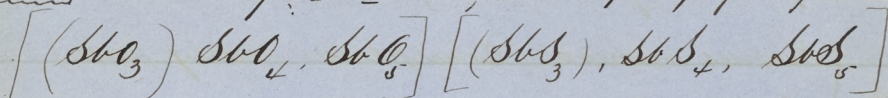
Ruthenium - Ru. 52 - Sp.gr. 8.1 - Claus 1845

Nickel - Ni 30 - Sp.gr. 9 Wollaston 1751

Nickel is obtained from native arsenurets of nickel. It forms a white alloy with Copper called German Silver

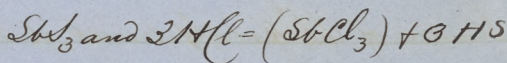
Cobalt. Co. 30 - Sp.gr. 8 - Brandt 1733

IX. Antimony (sti-bium) Sb. 129. Sp. gr. 6.7



1. As Peroxide - Antimonii Oxidum. Ed. Dub.
2. As Tersulphuref. (a) Antimonii Sulphuretum US
 (b) Antimonii Sulphuretum Preparatum Dub
 (c) Antimonii Sulphuretum Precipitatum US
3. As peroxide Combined with tersulphuref (a) Glass of Antimony (b) Crocus of Antimony
4. Oxidized and associated with phosphate of lime
 Pulvis Antimoniacus Ed
5. As Terechloride. Antimonii terechloridi Liquor Dub
6. As peroxide Combined with terechloride
 Oxychloride of Antimony. Powder of Algaroth
7. As Subsulphate of peroxide of antimony
8. As peroxide Combined with tartaric acid & potassa.

Antimonii Oxidum. Ed. Dub SbO_3



Antimonious Acid SbO_4

Antimonic acid SbO_5

Tersulphuret of antimony Sb_2S_3

not
offi-
cinal { Kermes mineral (tersulphuret nearly pure)
Golden Sulphur (probably a mixture of
 Sb_2S_3 , SbS_3 and S)

Antimonii Sulphuretum Præcipitatum U.S.

There are 12 acidifiable metals the most important of which is antimony. Antimony exists variously mineralized. Its principal ore is tersulphurets called Commercially Crude antimony.

Tersulphuret of antimony is separated from its matrix by placing the ore in large crucibles around which wood is placed and set fire to.

The tersulphuret melts & flows down into the lower crucible & when it gets full the matter is allowed to cool. This is then roasted and some of the Sulphuret loses Sulphur & gets oxygen & the balance of the tersulphuret is not altered. This mixture is an oxysulphuret of antimony. This is heated with half its weight of tartar to extract all the oxygen

and all the Sulphur, and metallic antimony sinks to the bottom of the crucible. It is a brittle metal of a crystalline structure in plates. It can be reduced to powder. When melted and thrown on a planed surface it runs about in metallic globules red hot and undergoes a peculiar Combustion, leaves behind peculiar traces. There are several official preparations containing antimony as seen in the table.

To form SbS_3 tersulphuret of antimony is dissolved in Hydrochloric acid forming trichloride of antimony & Sulphuretted hydrogen is given off as a gas.

Trichloride of antimony thrown in plenty of water forms 2 teroxides and 1 trichloride of antimony in a white precipitate falls to the bottom. Acting on this oxychloride with a weak solution of Carbonate of Soda, the trichloride is dissolved out & the teroxide is left, the basic oxide of the metal. It is the active medicinal Compound in the preparations of antimony. To make $SbCl_4$ dissolve

metallin antimony in an excess of nitric acid, and expose the product to a red heat & this substance is obtained in a white powder. Antimonic acid is obtained by oxidizing by excess of nitric acid, heated antimony to maximum SbO_3 , by a regulated heat not exceeding 600° driving off the excess of nitric acid. It is a yellowish white powder. SbO_4 & SbO_2 when given internally are somewhat inert SbS_4 & SbS_5 are not important. $SbCl_3$ is used to obtain 3 preparations. Kermes' mineral may be obtained by Solutions of Caustic fixed alkalies or Carbonate fixed alkalies, by heat alone.

LXI Glass of Antimony - 1 part tersulphuret & 8 of teroxide
Crocus of antimony 1 " " " 4 " "

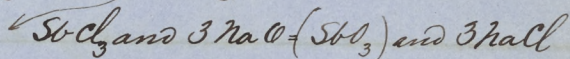
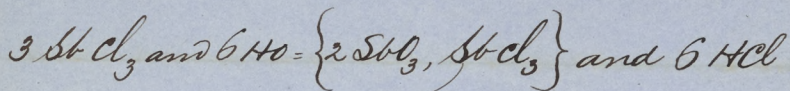
Pulvis Antimonialis. Ed Dub

Sb with Cl - $(SbCl_3)$, $SbCl_4$, $SbCl_5$

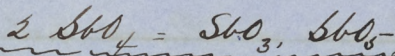
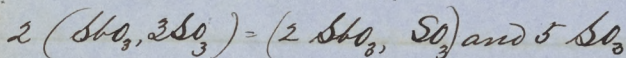
Tetrachloride of antimony $SbCl_4$ Antimonii

Chloridi Liquor Dub

Oxychloride of antimony (powder of algaroth) $2SbO_3, SbCl_3 + H_2O$



Subsulphate of teroxide of antimony $2 \text{ SbO}_3, \text{ SO}_3$



Glass of antimony is obtained from black tersulphure of antimony. When this is exposed in coarse powder to a roasting heat & stirred all the time Sulphurous acid is given off and oxygen is obtained. When the heat is raised after a while to a red heat no more Sulphur vapors come off. This mixture of oxysulphure of antimony is a grey powder called antimony ash. When exposed to an intense heat it will fuse, & is then to be poured on a brass plate where it Congeals in cakes, and when these are broken into fragments they constitute the glass of antimony. It is a hard substance, generally in thin pieces, translucent, & the transmitted light is of a garnet red color.

It is hard to powder and is not now much used in medicine on account of its different effects which seem to depend on the Condition of the stomach. It is used as a Substance from which to make Tartar Emetic in France, but first, it must be reduced to a very fine powder. It is a semivitrified Substance & is not solely a mixture of tersulphuret and teroxide but Contains 5% of Silica + 3% Sesquioxide of iron. Its Composition is considered to be $\frac{1}{2}$ part of SbS_3 and $\frac{1}{2}$ parts of SbO_3 . Focus of antimony is made by deflagrating nitrate of potassa and black tersulphuret of antimony in equal weights $\frac{1}{12}$ muriatic acid being employed, Nitrate of potassa ($NO_5 + KO$) is decomposed & also part of SbS_3 . The oxygen furnished by the decomposed NO_5 oxidizes the S and the Sb of the SbS_3 . The S becomes SO_3 and the Sb, SbO_3 . The SO_3 Combines with KO forming KO, SO_3 & there is a little overplus KO and some

Sulphuret of potassium, but the muriatic acid
 turns these into chloride of potassium. Washing
 this with plenty of water chloride of potassium
 and KO, SO_3 are washed away. The remaining
 insoluble mass is dried & constitutes crocus in
 the form of powder formerly official in the London
 pharmacopœia used to form Tartar Emetic. It can
 be melted & fused forming fused crocus & this also
 was used to obtain Tartar emetic. Unfused Crocus is of
 a saffron brown color; fused Crocus is of a liver brown
 color when good. It is supposed to contain 1 part of
 SbS_3 & 4 of SbO_3 . Pulvis Antimonialis is not
 official in the U.S. pharmacopœia because
 the antimonial powder is very unequal in its
 effects. According to the Ed pharmacopœia it is
 made by mixing black SbS_3 with an equal weight
 of horn shavings in an iron Crucible & exposing
 it for some time to the fire, constantly stirring.
 The mass is taken out & reduced to powder, pul

